Service Manual

Vela
Ventilator Systems

L1534 Revision B December 2004

Revision History

Date	Revision	Pages	Changes
March 2002	X1	All	Initial Draft
April 2002	X2	All	Added Engineering Drawings, Theory of Operation, Calibration and PM procedures
June 2002	X3	All	Added Extended Functions and UVT Test Screens. Added Error Codes.
August 2002	A	All	Final review & engineering release. Modified OVP, Calibration and screens.
December 2004	B	39	Replaced Figure 3.13 Umbrella Check Valve with Figure 3.13 Umbrella Check Valve (P/N 21950)

Warranty

THE Vela ventilator systems are warranted to be free from defects in material and workmanship and to meet the published specifications for two (2) years or 8,000 hours, whichever occurs first. The turbine only is warranted to be free from defects in material or workmanship for five (5) years or 40,000 hours whichever occurs first.

The liability of VIASYS Healthcare, Critical Care Division, (referred to as the Company) under this warranty is limited to replacing, repairing or issuing credit, at the discretion of the Company, for parts that become defective or fail to meet published specifications during the warranty period; the Company will not be liable under this warranty unless (A) the Company is promptly notified in writing by Buyer upon discovery of defects or failure to meet published specifications; (B) the defective unit or part is returned to the Company, transportation charges prepaid by Buyer; (C) the defective unit or part is received by the Company for adjustment no later than four weeks following the last day of the warranty period; and (D) the Company's examination of such unit or part shall disclose, to its satisfaction, that such defects or failures have not been caused by misuse, neglect, improper installation, unauthorized repair, alteration or accident.

Any authorization of the Company for repair or alteration by the Buyer must be in writing to prevent voiding the warranty. In no event shall the Company be liable to the Buyer for loss of profits, loss of use, consequential damage or damages of any kind based upon a claim for breach of warranty, other than the purchase price of any defective product covered hereunder.

The Company warranties as herein and above set forth shall not be enlarged, diminished or affected by, and no obligation or liability shall arise or grow out of the rendering of technical advice or service by the Company or its agents in connection with the Buyer's order of the products furnished hereunder.

Limitation of Liabilities

This warranty does not cover normal maintenance such as cleaning, adjustment or lubrication and updating of equipment parts. This warranty shall be void and shall not apply if the equipment is used with accessories or parts not manufactured by the Company or authorized for use in writing by the Company or if the equipment is not maintained in accordance with the prescribed schedule of maintenance.

The warranty stated above shall extend for a period of FIVE (5) years from date of shipment or 40,000 hours of use, whichever occurs first, with the following exceptions:

1. Components for monitoring of physical variables such as temperature, pressure, or flow are warranted for ninety (90) days from date of receipt.

2. Elastomeric components and other parts or components subject to deterioration, over which the Company has no control, are warranted for sixty (60) days from date of receipt.

3. Internal batteries are warranted for ninety (90) days from the date of receipt.

The foregoing is in lieu of any warranty, expressed or implied, including, without limitation, any warranty of merchantability, except as to title, and can be amended only in writing by a duly authorized representative of the Company.

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Notices

Copyright Notice

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Trademark Notices

Vela® is a registered trademark of VIASYS Healthcare, Critical Care Division in the U.S. and some other countries. All other brand names and product names mentioned in this manual are trademarks, registered trademarks, or trade names of their respective holders.

EMC Notice

This equipment generates, uses, and can radiate radio frequency energy. If not installed and used in accordance with the instructions in this manual, electromagnetic interference may result. The equipment has been tested and found to comply with the limits set forth in EN60601-1-2 for Medical Products. These limits provide reasonable protection against electromagnetic interference when operated in the intended use environments described in this manual.

The ventilator has been tested to conform to the following specifications:

MIL-STD-461D:1993, MIL-STD-462D:1993, EN55011:1991, IEC 1000-4-2:1994, IEC 1000-4-3:1994, IEC 1000-4-4:1994, IEC 1000-4-5:1994, QUASI-STATIC:1993

This ventilator is also designed and manufactured to comply with the safety requirements of IEC 601-1, IEC 601-2-12, CAN/CSA-C22.2 No. 601.1-M90, and UL 2601-1.

MRI Notice

This equipment contains electromagnetic components whose operation can be affected by intense electromagnetic fields.

Do not operate the ventilator in a MRI environment or in the vicinity of high-frequency surgical diathermy equipment, defibrillators, or short-wave therapy equipment. Electromagnetic interference could disrupt the operation of the ventilator.

Intended Use Notice

The Vela Ventilators are designed to provide ventilator support for the critical care management of infant, pediatric or adult patients with compromised lung function. They are intended to provide continuous respiratory support in an institutional health care environment. **They should only be operated by properly trained clinical personnel, under the direction of a physician.**

Regulatory Notice

Federal law restricts the sale of this device except by or on order of a physician.

IEC Classification

Type of Equipment: Medical Equipment, Class 1 type B
Adult/Pediatric/Infant Lung Ventilator

Declaration of Conformity Notice

This medical equipment complies with the Medical Device Directive, 93/42/EEC, and the following Technical Standards, to which Conformity is declared:

EN60601-1
EN60601-1-2
ISO 9001, EN 46001

CE
0086

EU Notified Body:

BSI (Reg. No. 0086)

Tradenames:

Vela

If you have a question regarding the Declaration of Conformity for this product, please contact VIASYS Healthcare, Critical Care Division at the number given in Appendix A.

Safety Information

Please review the following safety information prior to operating the ventilator. Attempting to operate the ventilator without fully understanding its features and functions may result in unsafe operating conditions.

Warnings and Cautions which are general to the use of the ventilator under all circumstances are included in this section. Some Warnings and Cautions are also inserted within the manual where they are most meaningful.

Notes are also located throughout the manual to provide additional information related to specific features.

If you have a question regarding the installation, set up, operation, or maintenance of the ventilator, contact VASYS Healthcare Customer Care as shown in Appendix A, Contact & Ordering Information.

Terms

WARNINGS	identify conditions or practices that could result in serious adverse reactions or potential safety hazards.
CAUTIONS	identify conditions or practices that could result in damage to the ventilator or other equipment.
NOTES	identify supplemental information to help you better understand how the ventilator works.

Warnings

Warnings and Cautions appear throughout this manual where they are relevant. The Warnings and Cautions listed here apply generally any time you operate the ventilator.

- The Vela Ventilator is intended for use by a trained practitioner under the direction of a qualified physician.
- When the ventilator is connected to a patient, a trained health care professional should be in attendance at all times to react to an alarm or other indications of a problem.
- Alarm loudness must be set above ambient sound in order to be heard.
- Always have an alternate means of ventilation available whenever the ventilator is in use.
- The operator should not touch the electrical connectors of the ventilator or accessories, and the patient simultaneously.
- Due to possible explosion hazard, the ventilator should not be used in the presence of flammable anesthetics.
- An audible alarm indicates an anomalous condition and should never go unheeded.
- Anti-static or electrically conductive hoses or tubing should not be used within the patient circuit.
- If a mechanical or electrical problem is recognized while running the Operational Verification Tests, or while operating the ventilator, the ventilator must be removed from use and referred to qualified personnel for servicing. Using an inoperative ventilator may result in patient injury.

- When a low gas supply alarm occurs, the oxygen concentration delivered to the patient will differ from that set on the O2 control setting.
- A source gas failure will change the FIO2 and may result in patient injury.
- The functioning of this equipment may be adversely affected by the operation of other equipment nearby, such as high frequency surgical (diathermy) equipment, defibrillators, short-wave therapy equipment, "walkie-talkies," or cellular phones.
- Water in the air supply can cause malfunction of this equipment.
- Do not block or restrict the Oxygen bleed port located on the instrument back panel. Equipment malfunction may result.
- Electric shock hazard - Do not remove any of the ventilator covers or panels. Refer *all* servicing to an authorized VIASYS Healthcare service technician.
- A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation. Upon loss of protective ground, all conductive parts including knobs and controls that may appear to be insulated, can render an electric shock. To avoid electrical shock, plug the power cord into a properly wired receptacle, use only the power cord supplied with the ventilator, and make sure the power cord is in good condition.

Cautions

The following cautions apply any time you work with the ventilator.

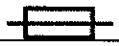
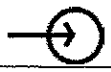
- When replacing fuses, ensure that new fuses are of the same type and value as those being replaced. Incorrect fuses can cause damage to the ventilator.
- A battery that is fully drained (i.e. void of any charge) may cause damage to the ventilator and should be replaced.
- All accessory equipment that is connected to the ventilator must comply with CSA/IEC601/UL2601.
- To avoid damage to the equipment, clean the air filter regularly.

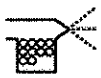
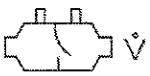
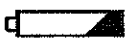
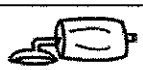
The following cautions apply when cleaning the ventilator or when sterilizing ventilator accessories.

- Do not sterilize the ventilator. The internal components are not compatible with sterilization techniques.
- Do not gas sterilize or steam autoclave tubing adapters or connectors in place. The tubing will, over time, take the shape of the adapter, causing poor connection and possible leaks.
- DO NOT submerge the ventilator or pour cleaning liquids over or into the ventilator.

Equipment Symbols

The following symbols may be referenced on the ventilator or in accompanying documentation

Symbol	Source/Compliance	Meaning
	Symbol #03-02 IEC 60878	Indicates ATTENTION, consult ACCOMPANYING DOCUMENTS
	Symbol #5016 IEC 60417	This symbol indicates a FUSE.
	Symbol #5034 IEC 60417 Symbol #01-36 IEC 60878	This symbol indicates INPUT.
	Symbol #5035 IEC 60417 Symbol #01-37 IEC 60878	This symbol indicates OUTPUT
	Symbol #5019 IEC 60417 Symbol #01-20 IEC 60878	This symbol indicates protective EARTH (ground).
	Symbol #5021 IEC 60417 Symbol # 01-24 IEC 60878	This symbol indicates the EQUIPOTENTIAL connection used to connect various parts of the equipment or of a system to the same potential, not necessarily being the earth (ground) potential (e.g., for local bonding).
	Symbol # 5333 IEC 60417 Symbol #02-03 IEC 60878	This symbol indicates TYPE BH equipment, which indicates equipment that provides a particular degree of protection against electric shock, particularly with regards to allowable leakage current and reliability of the protective earth connection.
	Symbol #5032 IEC 60417 Symbol #01-14 IEC 30878	This symbol indicates the equipment is suitable for alternating current.
	Symbol# 5049 IEC 60417	This Symbol indicates the ON condition for a part of the equipment. When pressed the ventilator will operate from the MAINS voltage (if connected) or internal or external batteries if the battery charge is within operating specifications.
	Symbol #5007 IEC 60417 Symbol #01-01 IEC 60878	Indicates ON (Power)
	Symbol #5008 IEC 60417 Symbol #01-02 IEC 60878	Indicates OFF (Power)
ACCEPT	Symbol #0651 ISO 7000	Horizontal return with line feed. Indicates ACCEPT entered values for a specific field.
CANCEL	Graphical Symbol in general use internationally for "DO NOT"	This symbol indicates CANCEL. Do not accept entered values. The ventilator continues to operate at previous settings.
	Symbol #5467 IEC 60417	Pressing the button with this symbol will FREEZE the current display.
	Symbol #5569 IEC 60417	This symbol indicates a CONTROL LOCK.

Symbol	Source/Compliance	Meaning
	VIASYS Healthcare symbol	This symbol represents a NEBULIZER.
	Symbol #5319 IEC 60417	This symbol indicates ALARM SILENCE
	Symbol #5307 IEC 60417	This symbol indicates ALARM RESET
	VIASYS Healthcare symbol	Increase OXYGEN
	VIASYS Healthcare symbol	Indicates VARIABLE ORIFICE FLOW SENSOR
	Symbol #5031 IEC 60417	This symbol indicates DIRECT CURRENT (DC)
	Symbol #5546 IEC 60417	This symbol indicates the INTERNAL BATTERY STATUS display
	VIASYS Healthcare symbol	This symbol indicates INSPIRATORY HOLD
	VIASYS Healthcare symbol	This symbol indicates EXPIRATORY HOLD
	VIASYS Healthcare symbol	This symbol indicates MANUAL BREATH

Chapter 1 Introduction

General Instructions

When disassembling or assembling the Vela, refer to the pneumatic schematic, tubing diagram, and the wiring diagram shown in Appendix B and the appropriate schematics and assembly drawings for each assembly. The illustrations shown in this manual are for reference only, current revisions of these diagrams and schematics are available to qualified personnel from VIASYS Healthcare, Critical Care Division, Technical Support.

Always take standard ESD precautions when working on Vela ventilator systems.

Ensure the ventilator is disconnected from the AC power supply before performing and repairs or maintenance. When you remove any of the ventilator covers or panels, immediately disconnect the internal battery "quick release" connector (see figure 3.1) before working on the ventilator.

Recommended Tools & Equipment

Note

Before using any test equipment [electronic or pneumatic] for calibration procedures, the accuracy of the instruments must be verified by a testing laboratory. The laboratory master test instruments must be traceable to the NIST (National Institute of Standards Technology) or equivalent.
When variances exist between the indicated and actual values, the calibration curves [provided for each instrument by the testing laboratory] must be used to establish the actual correct values. This certification procedure should be performed at least once every six months. More frequent certification may be required based on usage.

Long & short Philips screwdrivers	Pressure Manometer (cmH2O and psig)
Flat bladed screwdriver	Adult Test Lung P/N 33754
¼" Nut Dirver	Adult Patient Circuit P/N 10684
5/16" Nut Driver	Variable Orifice Flow Sensor assembly P/N 15972
7/8" Nut Driver	Valve Body P/N 20005
11/32" Nut Drivel	Tapered nipple P/N 00680
Digital Volt Meter	Hex nut P/N 00822
Tack puller or Needle nosed pliers	Regulator P/N 6754
Diagonal cutters	1/8" ID Tubing tee P/N 00358 D (10pk)
1" and ¾" open ended wrenches	1/8" ID silicone tubing P/N 04029 X (50ft)

Recommended Maintenance Schedules

Schedules

Every 500 hours , the fan and ambient air filters should be cleaned and replaced if necessary.

Every 5000 hours, VIASYS recommends that the following Preventive Maintenance procedure be performed (see chapter 4 for instructions). This procedure includes:

- Replacement of the fan filter, the ambient air filter, the cone filters in the high & low pressure gas inlets and the turbine mufflers/filter.
- Perform verification procedures described in Chapter 4
- Calibration of the transducers & solenoids if necessary.

Every 10,000 hours or every two years, whichever occurs sooner, the internal oxygen sensor should be replaced.

Maintenance on the Vela should only be carried out by a trained and authorized service technician. VIASYS Healthcare will make available to qualified technicians, service manuals and such items as circuit diagrams, component parts lists, calibration instructions and other information to assist in repair of those parts of the ventilator designated by the manufacturer as repairable items.

The drawings, diagrams and schematics included in this manual are for reference only and may be updated separately from this manual after publication. For current revisions of all documentation, contact VIASYS Healthcare Tech Support at the numbers provided in Appendix A.

Chapter 2 Theory of Operation

General Device Description

The Vela Ventilator uses a revolutionary turbine gas delivery system with sophisticated microprocessor control. Its Graphical User Interface provides support for pediatric to adult patients. The Vela can deliver clinically advanced modes of ventilation like Pressure Support and can be powered with an internal battery or AC power for an more extensive patient range.

Pneumatic System Overview

The Vela ventilator pneumatic system is electromechanical and is comprised of four major subsystems, each containing several components. These systems are the flow delivery system, the exhalation system, the safety system and the inspiratory hold valve. Individual subsystems are discussed in detail below.

Flow Delivery System

This electromechanical system controls all inspiratory flow to the patient. The system delivers flow to satisfy criteria for many breath types, including volume controlled, pressure controlled, and pressure supported. The system comprises a turbine, differential pressure transducer, 2 auto-zero valves, and an optical encoder speed transducer. When a breath is initiated, the controller controls the speed of the turbine to achieve the required flow rate.

The speed and differential pressure transducer signals function as control inputs to ensure that the proper flow rate is delivered even when backpressure varies. Periodically, the auto zero valves activate to reference both sides of the differential pressure transducer to ambient pressure. The offset is recorded by the controller, and is used as a correction for future pressure measurements. This compensates for long term and temperature drift. Materials exposed to patient gases include compatible plastics, aluminum, and plated steel.

Exhalation System

The exhalation system controls the flow of gas from the patient's lungs during the exhalation phase of a breath. This electromechanical subsystem is made up of an exhalation valve, a flow transducer, a differential pressure transducer, an airway pressure transducer, and three auto zero solenoid valves. During exhalation, the outflow of gases is regulated by the exhalation valve to achieve the set PEEP. The exhalation valve is comprised of an electromagnetic linear actuator operating against a mechanical poppet/seat. The gas flow travels through the flow transducer. The flow transducer is a variable orifice type and creates a differential pressure proportional to flow. This differential pressure is transmitted to the differential pressure transducer, which converts the pressure signal to an electrical signal. The controller uses this signal for flow triggering and to monitor exhaled tidal volume. The airway pressure transducer reads pressure in the exhalation leg of the patient circuit. This signal is used as a feedback signal for controlling PEEP, pressure control, pressure support, and various pressure monitors. Periodically, the auto zero valves activate to reference the differential and airway pressure transducers to ambient pressure. The offset is recorded by the controller, and is used as an offset for future pressure measurements. This compensates for long term and temperature drift. Materials exposed to patient gases include compatible plastics, aluminum, and stainless steel.

Safety System

The mechanical safety system ensures that the patient can breath spontaneously from room air and that the patient pressure is limited to a maximum preset value in the event of a ventilator malfunction. This mechanical system consists of a pressure relief valve and a sub ambient relief valve. In the event of a ventilator malfunction that results in high pressure, the pressure is limited by a relief valve. The relief valve consists of a user-adjustable, spring-loaded poppet acting against a seat.

In the event the ventilator fails to deliver a breath, the patient may inspire spontaneously by drawing room air through the sub ambient relief valve.

Materials exposed to patient gas are aluminum, compatible rubber, and compatible plastics.

Inspiratory Hold Valve

The inspiratory hold valve is an electromechanical solenoid valve. If activated, the inspiratory hold valve blocks flow between the flow delivery system and the patient. This valve is activate during inspiratory hold and maximum inspiratory pressure maneuvers. Materials exposed to patient gases are aluminum and compatible rubber and plastic.

Oxygen Blending System

The optional oxygen blending system is made up of an O2 Inlet Transducer, five solenoid valves, five flow orifices, an inlet filter, and an accumulator. When a breath is initiated, the turbine draws mixed gas from the accumulator. Filtered air is drawn into the accumulator through the filter. Oxygen is supplied to the accumulator through the solenoids and orifices. The controller opens and closes the valves as required to supply the correct amount of oxygen to satisfy the O2 setting and the flow demand. The signal from the O2 inlet pressure transducer is used to compensated delivered O2 for O2 inlet pressure variations. Surfaces exposed to patient gas are constructed from compatible plastics, plated steel, and aluminum.

There is also an optional oxygen inlet port, which allows for low-flow titration of oxygen into the gas output of this device.

Electronic Overview

The Vela ventilator electronic system is comprised of several subsystems, each containing numerous components. These subsystems are the GUI System, the Power System, the Main Controller System, and the Exhalation and Flow Delivery systems. Individual subsystems are discussed in detail.

User interface module (UIM)

The UIM consists of a 10.4-inch, 800x600 active matrix LCD with an analog resistive touch screen overlay, a back light inverter, a set of membrane key panels, an optical encoder, and a Control PCB. Software and the touch screen provide a set of context sensitive soft keys. The membrane panel provides a set of hard (permanent) keys for dedicated functions. Selecting the function with a soft key and adjusting the setting using the optical encoder changes a parameter. The parameter is accepted or canceled by pressing the appropriate membrane key.

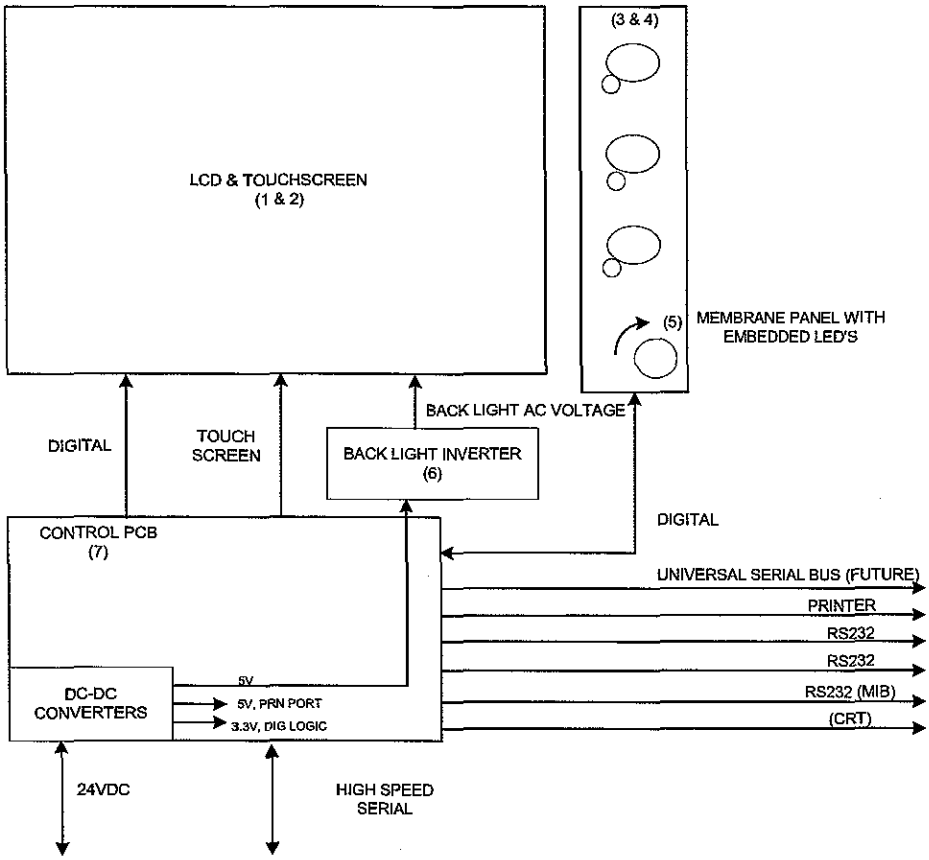


Figure 1 -- User Interface Design Module Block Diagram

The UIM performs all ventilator control functions, gas calculations, monitoring and user interface functions. The UIM uses a Graphical User Interface (GUI) via the active matrix SVGA LCD and resistive touch screen to provide system and patient information to the user and to allow the user to modify ventilator settings. The Monitor MCU handles all user interface requirements, including updating the active matrix liquid crystal display (LCD), monitoring the membrane keypad, analog resistive touch screen, and optical encoder for activity. The Monitor MCU also performs all the input/output functions of the UIM, including RS-232, printer, video output, and IEEE 1073 Medical Information Bus (MIB). Communication between the Control and Monitor MCU's is accomplished via an 8 bit dual port SRAM.

Liquid Crystal Display

The liquid crystal display (LCD) provides graphical and digital feedback to the clinician. The panel is a 10.4" SVGA, 800x600 pixel, active matrix LCD. The LCD is used to implement the graphical user interface (GUI). It provides all of the adjustable controls and alarms, as well as displays waveforms, loops, digital monitors and alarm status in real time.

Touch Screen

The touch screen is a 10.4" analog resistive overlay on a piece of glass, which is placed over an LCD screen. The touch screen and the LCD together provide a set of software configurable soft keys. The software enables the keys to be context sensitive. The touch screen has a resolution of 1024x1024. Physically, the touch screen consists of two opposing transparent resistive layers separated by insulating spacers. Touching the screen brings the two opposing layers into electrical contact. The Y coordinate is determined by applying a voltage from top to bottom on the top resistive layer. This creates a voltage gradient across this layer. The point of contact forms a voltage divider, which is read by the analog-to-digital converter. The X coordinate is determined by applying a voltage from left to right on the bottom resistive layer. Again this creates a voltage gradient and the point of contact forms a divider, which is read with an analog-to-digital converter.

Membrane Panel

The membrane panel provides a set of permanent dedicated keys, which enable control of ventilator functions. The membrane panel also provides visual display using embedded light emitting diodes (LEDs). The membrane panel consists of membrane switches, which are read by the monitor CPU. The switches form a matrix of rows and columns. A key closure causes an interrupt to the monitor CPU, which responds by scanning the key matrix to determine which key has been pressed.

Light Emitting Diodes (Leds)

Some of the membrane keys require LED's to indicate when the key is active. The LED's are embedded into the membrane panels.

Optical Encoder

The optical encoder allows settings to be modified. The setting is selected by pressing a soft key on the LCD and then modified by turning the optical encoder (data dial) to change the value. When the encoder is rotated two pulse streams are generated, phase A and B. When the encoder is turned clockwise, phase A leads B by 90 degrees. When the direction is counter clockwise, phase B leads A by 90 degrees. The electronics uses the phase information to drive an up-down counter, which is read by the monitor CPU. The optical encoder is not interrupt-driven and therefore must be polled by the monitor CPU.

Back Light Inverter

The back light inverter converts 5 VDC into the high frequency AC voltage necessary to power the LCD back light, which is used to illuminate the LCD.

Power System

The Power System conditions and controls electrical energy from the AC line input and the internal battery. When energy is available from the AC line, the ventilator operates from this source, and also recharges the internal battery. When AC line power is not available, the power system draws energy from the internal battery. The power system uses energy efficient DC-to-DC converter technology to convert energy from the AC line or battery to appropriate voltages and currents to supply power to ventilator components and systems.

Main Controller System

The Main Controller System is comprised of three Pressure Transducers, an Analog-to-Digital Converter, two Digital-to-Analog Converters, the Input-Output Processor, Solenoid Valves, and the Watchdog and Hardware Fault Monitors.

One of the pressure transducers measures the patient circuit pressure. This pressure is an input to the controller. A differential pressure transducer measures the pressure across the turbine. This pressure is also an input to the controller. A second differential pressure transducer is used to measure the flow at the outlet of the exhalation valve. This pressure is also an input to the controller.

Analog to digital converters are used to change the analog pressure signals into measured binary numeric values for use by the microprocessor in the controller.

Digital to Analog converters are used to change the binary numeric commands generated by the microprocessor in the controller into analog signals which drive the turbine and exhalation valve.

The Input-Output Processor is a small microcontroller which, under software control, performs several repetitive tasks such as generating the refresh signals for the display system, cycling the A-to-D converters through a pattern of measurements from the multiple signal sources, and scanning the control panel for pressed buttons. Such repetitive tasks are thereby off loaded from the Main Processor.

Solenoid Valves and Valve Drivers (including the Auto Zero valves) are employed on the Circuit Pressure transducer and on the Turbine Differential Pressure Transducer. These valves allow the controller software to compensate for long term drift and temperature induced zero shift in the pressure transducers by periodically rechecking the zero pressure readings. Similar solenoid valves are employed in the Oxygen Blending System. The valve drivers for the Auto Zero and Blender valves are similar.

The Main Processor is a 386-type CPU which controls all ventilator functions. All user settings for alarms, controls, ventilation mode, waveform, and monitoried data are stored here and are combined with measured pressure, flow, and speed data to cause the ventilator to function. The algorithms, formulae, and control functions which define ventilator behavior are contained in the software program executed by the CPU.

The Watchdog Timer and Hardware Fault

Monitors shut down the ventilator if a malfunciton is detected. The Watchdog Timer consists of two timers and a PAL containing a state machine. The Main Controller CPU must communicate with a state machine at intervals within a time window set by the two timers. The CPU must obtain a key from the PAL and send the correct address and data response back to the state machine at each interval. If the response is incorrect, or comes at an invalid time, the Watchdog shuts down the CPU and forces the ventilator hardware to a safe state. The Hardware Fault Monitors check the status of the power supplies to the ventilator electornics. If any is out of the safe operationg range, the ventilator will shut down and cannot be made to operate until the fault is corrected.

Exhalation System

The electrical portion of the exhalation system is comprised of the Exhalation Valve Driver Circuitry. The driver converts the low voltage signal output by a D-to-A converter into a controlled constant current which energizes the linear solenoid positioner in the exhalation valve.

Flow Delivery System

The electrical portion of the flow delivery system is comprised of a 3 Phase Brushless Motor Driver, and an Optical Speed Transducer.

The 3 Phase Brushless DC Motor Driver converts the low voltage signal output by a D-to-A converter into three controlled currents which energize the three motor phases and cause the motor to create a torque, resulting in motor rotation. The torque generated is a function of current, and therefore of the control voltage from the D-to-A converter. The speed of rotation is monitored by the optical Speed Transducer. The transducer outputs a train of pulses with a frequency proportional to the rotational speed of the motor. This pulse train is a control feedback input to the controller.

Oxygen Blending System

The electrical portion of the optional oxygen blending system is made up of a safety solenoid, a pressure regulator set to 40 PSI, an O2 Inlet Transducer, five Solenoid Valves, one Nebulizer solenoid, and the driver circuitry for the solenoid valves.

The Oxygen Inlet Pressure Transducer measures the incoming gas pressure so that O2 delivery can be compensated for inlet pressure fluctuations.

The Solenoid Valves are energized and deenergized under software control by the Main controller to supply the correct amount of oxygen to satisfy the current O2 setting and current gas flow demand.

The driver circuitry translates the binary logic signals presented by the controller to larger voltage and currents suitable for energizing the Solenoid Valves.

Chapter 3 Disassembly & Assembly

General Instructions and Warnings

When performing the procedures in this chapter, refer to the Vela wiring and tubing diagrams. Reference copies of these are located in Appendix B of this manual. Ensure that you follow these safety warnings and precautions:

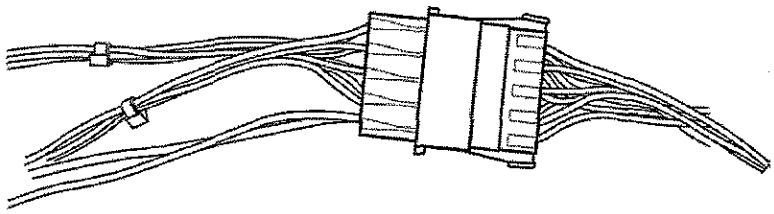


Figure 3.1 Battery Disconnect Molex Connector

WARNING

Always disconnect the main power cable before removing the instrument cover and disconnect the battery once the top cover and battery tray have been removed to prevent injury and/or damage to the VELA Ventilator System (see figure 3.1).

CAUTION

The Vela contains ESD susceptible components. Ensure you are properly grounded before performing any service or maintenance procedures and store ESD susceptible electrical components in an anti-static bag to prevent damage to the component.

Note

When the batteries are disconnected, the system will automatically re-set the battery status memory and will initiate an 18-hour re-charge cycle upon re-connect. During this period, the red DC status light will remain on. If the DC status light remains lit after the initial charging period has expired, contact VIASYS tech support as described in Appendix A for a replacement battery.

Note

Do not cut the main harness tie wraps since the entire harness is regarded as one component.

Note

The terms left and right refer to a view from the front of the unit looking towards the rear.

Required Tools

Long & short Philips screwdrivers	11/32" Nut Driver
Flat bladed screwdriver	Digital Volt Meter
¼" Nut Dirver	Tack puller or Needle nosed pliers
5/16" Nut Driver	Diagonal cutters
7/8" Nut Driver	1" and ¾" open ended wrenches

Disassembly and Reassembly Procedures

To perform a complete disassembly of the unit, follow all of the steps in each *removal* section, in the order presented in this chapter. To reassemble the unit, follow all of the steps in each *installation* section, starting with the last component and finishing with the power cable installation instructions.

Power Cable

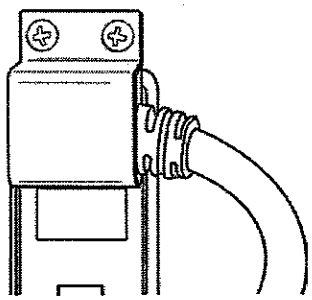


Figure 3.2 Power Cable Connector with Guard

Removal

1. Remove the (2)Phillips pan-head screws in the top portion of the power cable guard at the rear of the unit (see figure 3.2)
2. Remove the guard and unplug the power cable.

Installation

1. Plug the power cable into the rear of the unit.
2. Install the power cable guard with the (2) Phillips pan-head screws in the top portion.

Top Cover Part number 15893

Removal

1. Remove the power cable.
2. Remove the (3) Phillips pan-head screws in the upper rear of the front panel (if present).
3. Remove the (4) Phillips pan-head screws in the back panel.
4. Remove the (3) screws from the bottom of each side of the ventilator (if present).

Note

The configuration of the screws securing the cover will depend on the model of Vela that you are working with.

5. When all screws have been removed, slide the top cover towards the rear of the unit and lift off.

CAUTION

The SVGA output ribbon cable lies directly beneath the top cover assembly running from the front of the Vela to the rear. It can be damaged if care is not taken when removing the cover. Make sure that the cover clears this cable before sliding it back.

Installation

1. Install the top cover by sliding it toward the front of the unit, over the side rails, and snap into place.
2. Install the (4) Phillips pan-head screws in the back panel.
3. **Do not** re-install the (3) Phillips pan-head screws in the upper rear of the front panel if present. They have been removed from later versions of the Vela.
4. Install the power cable.

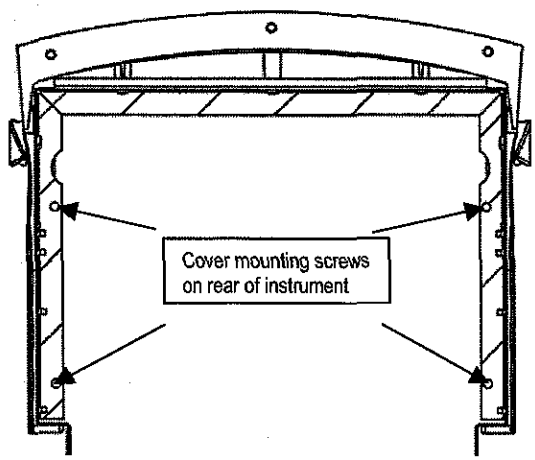


Figure 3.3 Cover Assembly from the rear

Battery Tray Part Number 10633

Removal

1. Remove the power cable and top cover.
2. Remove the (4) Phillips pan-head screws in the battery tray.
3. Lift the battery tray out of the unit.
4. Disconnect the batteries from the white Molex DC power connector (see figure 3.4

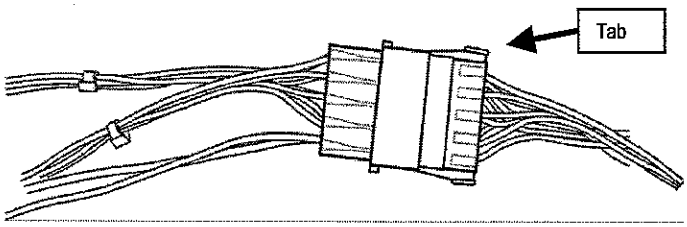


Figure 3.4 Large white Molex battery disconnect

To release connector, push in locking tabs

To attach push until locking tabs engage.

Note

When the batteries are disconnected, the system will automatically re-set the battery status memory and will initiate an 18-hour re-charge cycle upon re-connect. During this period, the red DC status light will remain on. If the DC status light remains lit after the initial charging period has expired, contact VIASYS tech support as described in Appendix A for a replacement battery.

Installation

1. Connect the white Molex DC power connector.
2. Ensure the Molex connector is pushed down into the unit behind the muffler tubes and install the battery tray. The tray is correctly installed when the wires run towards the rear of the unit.
3. Secure the battery tray to the left & right panels with (4) Phillips pan-head screws.
4. Install the top cover and re-connect the power cable and the power cable guard.

Battery Tray Parts List

Item	Part number	Description	Qty	UM
1	21363	Tray, battery	1	Ea
2	52000-00190	Grommet 11/16 id	0	Ea
3	21543	Battery 12v, 2.7 Ahr, ni-mh	4	Ea
4	15719	Cable assy, battery tray	1	Ea
5	20742	Bracket, capacitor	2	Ea
6	21068	Foam pad, capacitor bracket	2	Ea
7	64084	Capacitor elect 0.1f 63vdc	1	Ea
8	04383	Washer, lock int #6	4	Ea
9	07212	Nut, 6-32 x .093 depth	8	Ea
10	05038	Tie, strap	4	Ea
11	08231	Mounting bracket, cable tie	2	Ea
12	07803	Cable tie	2	Ea
14	09349x	Tape, adh-2s,2" x .045"	0	Ft

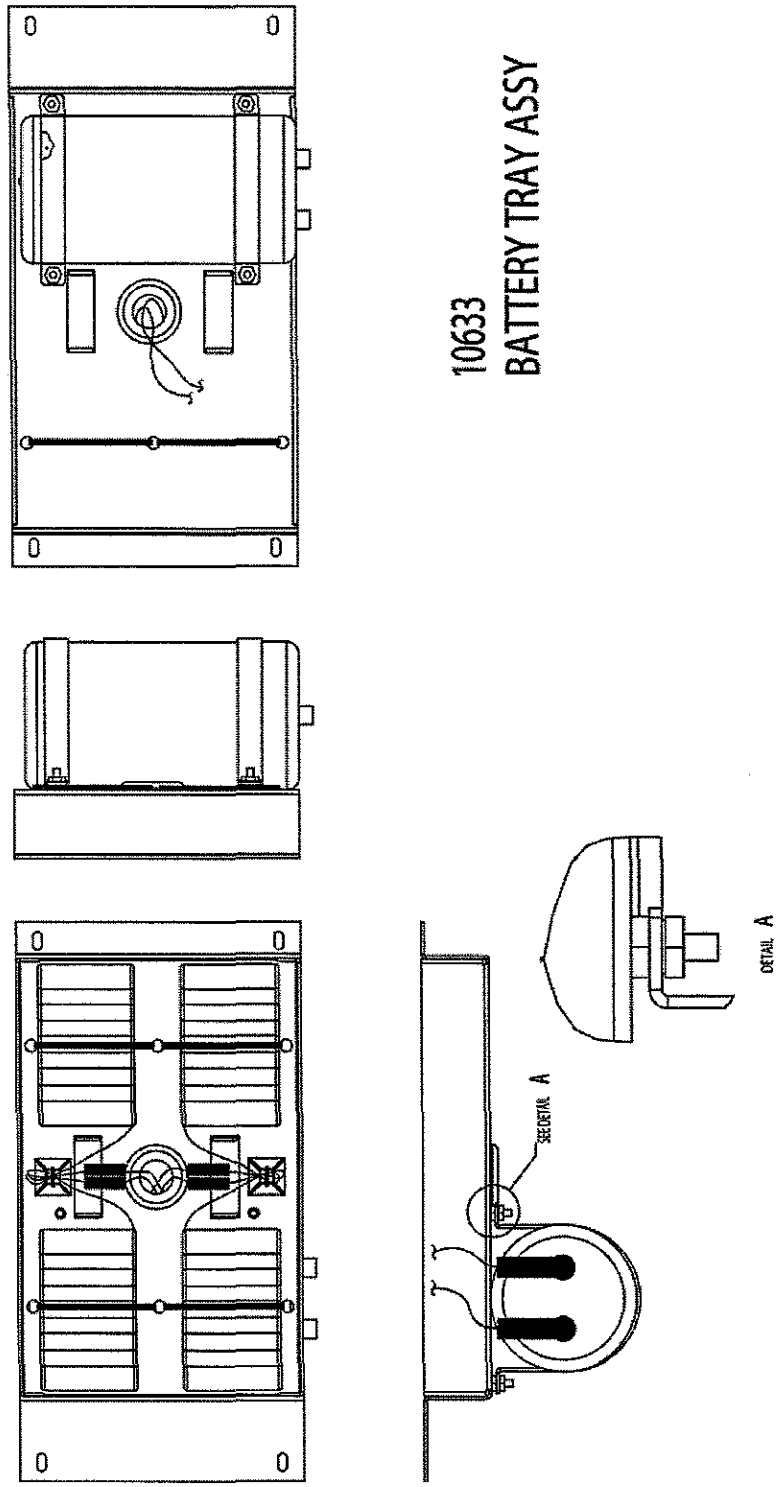


Figure 3.5 Battery Tray and large capacitor assembly

PCMCIA Cards

The PCMCIA card is located inside the unit. It contains the Vela software.

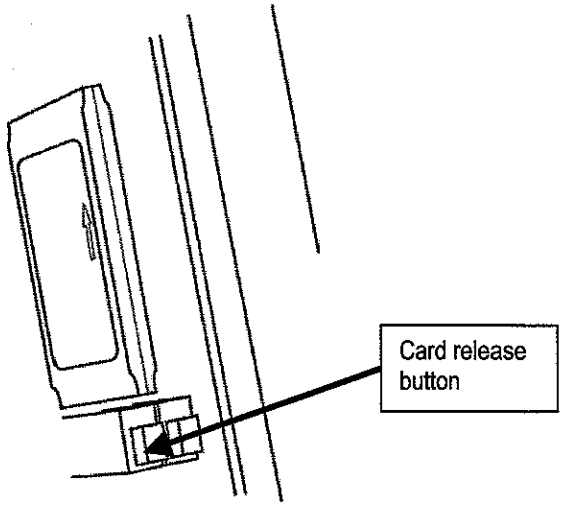


Figure 3.6 PCMCIA Card in place

Removal

1. Remove the power cable, top cover, and battery tray.
2. Push in the button under the card to release. (see figure 3.6)
3. Gently slide the card out of its socket.

Installation

1. Slide the card into the socket in the direction of the arrow printed on the card.
2. Click card into place.
3. Install the battery tray, top cover, and power cable.

Left Panel

The left panel is structural only and has no components attached to it.

Removal

1. Remove the power cable, top cover, and battery tray.
2. Remove the (2) Phillips countersink screws at the rear of the panel.
3. Remove the (1) Phillips countersink screw in the upper front of the panel.
4. Lift out the left panel.

Installation

1. Slide the front of the left panel behind the lip on the front panel and align the back of the panel with the rear panel edge.
2. Install the (2) Phillips countersink screws in the rear of the right panel.
3. Install the (1) Phillips countersink screw in the upper front of the right panel.
4. Install the battery tray, top cover, and power cable.

Right Panel Containing the Power PCB P/N 15894

Note

The internal battery fuse is located on the power PCB. Call Viasys if this fuse needs replacing.

Removal

1. Remove the power cable, top cover, and battery tray.
2. Remove the (2) Phillips countersink screws from the right side of the rear panel.
3. Remove the (1) Phillips countersink screw in the upper front of the right panel.
4. Remove the (1) Phillips pan-head screw in the lower center of the right panel.
5. Gently lift out the panel and the power PCB. Lay the panel flat and make the following disconnections:

Ref on Pwr PCB	Connector Desc	Connection made	Cable Assy P/Number
J1	26-pin ribbon cable	to J2 on main PCB	P/N 15494
J2	3-pin	to fan assembly	
J5	14-pin	to J5 on main PCB (in main harness)	
J6	10-pin	to P2 on turbine motor driver PCB	
J7	small 2-pin	to main power switch	
J300	large 2-pin	to battery DC power (in main harness)	
J400	4-pin quick disconnect	to SVGA PCB	
P1-L/N	AC line in	to power (black-power, white-neutral)	P/N 15890
		to ground lug (ground)	

Note

Do NOT remove the connector from J4 of the power PCB.

Installation

Make the following connections to the Power PCB.

Ref on Pwr PCB	Connector Desc	Connection made	Cable Assy P/Number
J1	26-pin ribbon cable	from J2 on main PCB	P/N 15494
J2	3-pin	from fan assembly	
J5	14-pin	from J5 on main PCB (in main harness)	
J6	10-pin	from P2 on turbine motor driver PCB	
J7	small 2-pin	from main power switch	
J300	large 2-pin	from battery DC power (in main harness)	
J400	4-pin quick disconnect	from SVGA PCB	
P1-L/N	AC line in	to power (black-power, white-neutral)	P/N 15890
		from ground lug (ground)	

WARNING

Ensure that the power cables are correctly connected to prevent injury and/or damage to the unit.

CAUTION

Ensure that J5 is pinned properly since an incorrect connection could damage the power PCB.

6. Slide the right panel into the front panel, ensuring that it rests on the bottom rail.
7. Install the (1) Phillips pan-head screw in the lower center of the panel.
8. Install the (1) Phillips countersink screw in the upper front of the panel.
9. Install the (2) Phillips countersink screws in the side of the rear panel.
10. Install the battery tray, top cover, and power cable.

Note

The Vela right panel assembly with the power board attached is supplied as a single complete assembly part number 15894. Do not attempt to disassemble or to replace individual components.

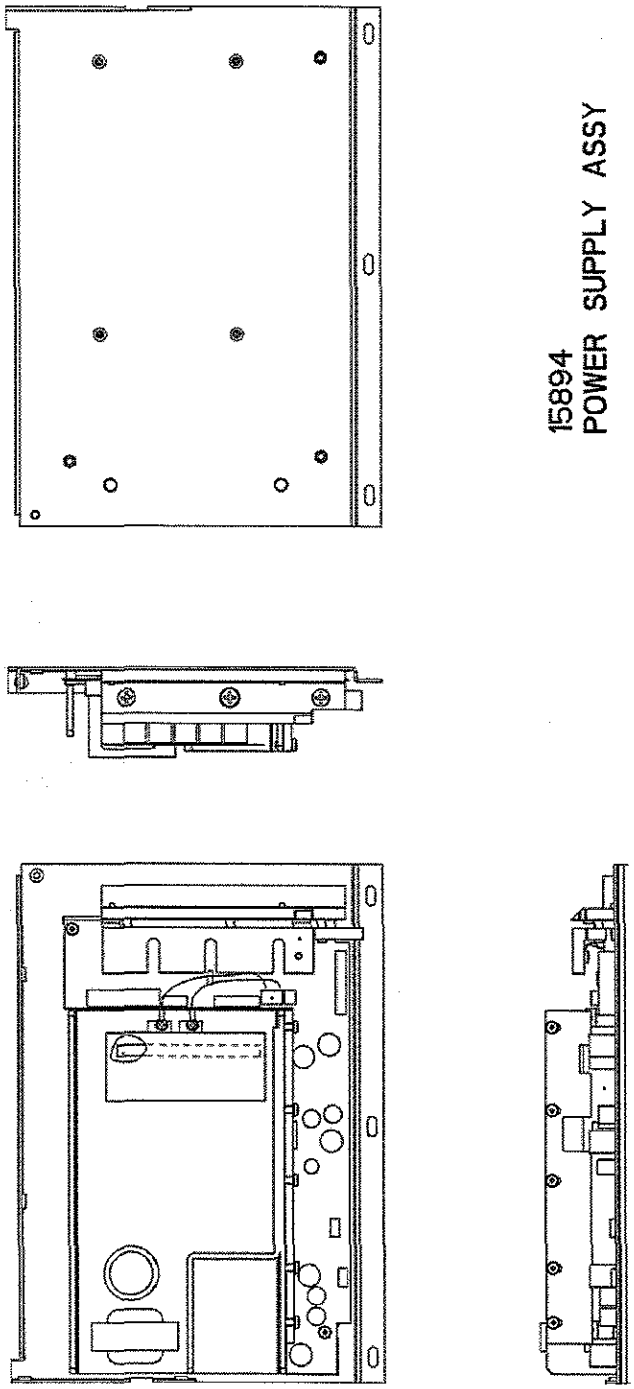


Figure 3.7 Right Panel and Power PCB

Front Panel Part number 15869

Removal

1. Remove the power cable, top cover, battery tray, right panel, and left panel.
2. Disconnect the following from the main PCB:

JP2	40-pin ribbon cable	to JP1 on the SVGA out PCB	
J301	12-pin	to J301 on the blender PCB	P/N 15497

Note

Disconnect the video cable from JP2 on the main PCB rather than from JP1 on the SVGA out PCB.

3. Disconnect the green oxygen nebulizer tube.
4. Remove the (2) Phillips pan-head screws behind the front panel at the lower left and right.
5. Disconnect the 1/8" silicone tube #4 from P2 and #5 from P1 on the exhalation differential transducer, and #1 from the turbine.
6. Disconnect the 1/16" silicone tubes from the common (front) ports of the turbine outlet auto-zero solenoid (to the main tubing harness), the turbine inlet auto-zero solenoid (to the turbine), and the airway pressure auto-zero solenoid (Nafian tube to the exhalation valve receptacle).
7. Disconnect the following from the main PCB:

J4	8-pin	to J1 on the FIO2 monitoring PCB	
J900	2-pin	(alarm loudness) to alarm potentiometer	
J701	5-pin	to turbine optic encoder and thermistor	
J401	4-pin	to exhalation valve	
U719	fiberoptic	to rear panel connector	
J5	14-pin	to J5 on power PCB	
J302	2-pin	to inspiratory hold solenoid on manifold base	
J2	26-pin	to J1 on power PCB	P/N 15494
J905	3-pin	to J2 on remote alarm (nurse call) PCB	
AL901	(hard-wired) 2-prong	to alarm cable connector	

Installation

1. Connect the green oxygen nebulizer tube.
2. Connect the following to the main PCB:

J401	4-pin	from exhalation valve	
J701	5-pin	from turbine optic encoder and thermistor	
U719	fiberoptic	from rear panel connector	
J5	14-pin	from J5 on power PCB	
J2	26-pin	from J1 on power PCB	P/N 15494
J905	3-pin	from J2 on remote alarm (nurse call) PCB	

3. Slide the front panel into place and secure the (2) Phillips panhead screws behind the front panel at the lower left and right.
4. Connect the following to the main PCB:

J302	2-pin	from inspiratory hold solenoid on manifold base	
J4	8-pin	from J1 on the FIO2 monitoring PCB	
J301	12-pin	from J301 on the blender PCB	P/N 15497
AL901	(hard-wired) 2-prong	from alarm cable connector	
J900	2-pin	alarm loudness cable from alarm potentiometer	

5. Connect the 1/16" silicone tubes to the common (front) ports of the turbine outlet auto-zero solenoid (from the main tubing harness), the turbine inlet auto-zero solenoid (from the turbine), and the airway pressure auto-zero solenoid (Nafian tube from the exhalation valve receptacle).
6. Connect the 1/8" silicone tube #4 to P2 and #5 to P1 on the exhalation differential transducer, and #1 to the turbine.
7. Connect the following to the main PCB:
   JP2 40-pin ribbon cable from JP1 on the SVGA out PCB

Note

Ensure that the fiber optic cable runs under the turbine muffler, that the tubing runs over the nebulizer line and is not pinched in between the front and base panels, and that the cable from J701 is securely connected to the turbine.

Parts List – Front Panel Part Number 15869

Item	Part Number	Part Description	Qty	U/M
1	21374	PANEL, FRONT	1	EA
2	52130	PCBA, MAIN	1	EA
3	53002-16206	SCREW, 6-32 X 3/8 STL ZN PLT PPH PNH	12	EA*
4	52000	PCBA, VELA VIDEO (SVGA PCB)	1	EA
5	15532	IC, PAL, PROGRAMMED	1	EA
6	15868	DISPLAY MODULE ASSY	1	EA
11	21368	BEZEL, DISPLAY	1	EA
12	80435	SWITCH, MEMBRANE	1	EA
15	44027	NUT, 4-40,LOCKING, HEX, STEEL	2	EA*
16	71046	NUT, 1/4-28, E-KEPS	1	EA*
21	66100	TOUCHSCREEN, 10.4" RESISTIVE"	1	EA
23	52000-01177	TAPE FOAM .025 THK .31 WIDE TWO SIDED	0	RL*
25	56060-30011	OPTICAL ENCODER	1	EA
26	52000-00475	NUT HEX	1	EA*
27	53027-13802	WASHER, LOCK 3/8	1	EA*
28	20415	CONN, FTG 1/8 TUBE TAPER	1	EA
29	15991	CONN ASSY, FLOW SENSOR BHD, VELA	1	EA
30	15961	CABLE ASSY, FLOW SENSOR - MAIN BOARD	1	EA
31	15962	CABLE ASSY, VIDEO BOARD TO POWER	1	EA
32	15963	CABLE ASSY, VIDEO BOARD TO MAIN BOARD	1	EA
33	21560	KNOB, SPINNER-1.50	1	EA
34	53002-46204	SCR 6-32X1/4 SS PPH PNH	4	EA*
35	10632	TUBING ASSY, 1/8 X 1/16	3	EA

* Commonly found hardware items are not supplied by VIASYS Healthcare.

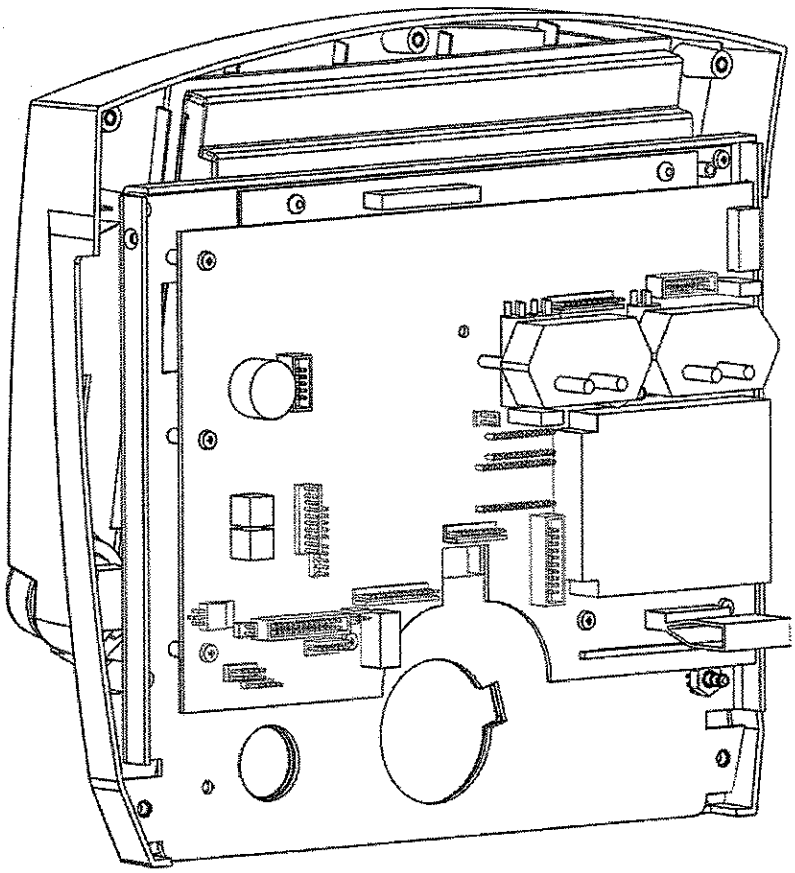


Figure 3.8 Front panel with main PCB

Main PCB (on Front Panel) P/N 52130

Removal

1. Remove the power cable, top cover, battery tray, right panel, left panel, and front panel.
2. Disconnect the following from the main PCB:

J801	20-pin	to J801 on the flow sensor PCB (in harness)
J1210	5-pin (gray top, green)	to the flow sensor PCB (in P/N 15961 harness)
J3	10-pin	to the flow sensor PCB (in P/N 15961 harness)
J1211	5-pin (blue wire-top)	to the SVGA PCB
J1	5-pin (orange wire)	to SVGA PCB (position wire on 2nd pin from right)
J1	5-pin (gray-left)	to SVGA PCB
J601	5-pin	to SVGA PCB

3. Loosen (7) Phillips pan-head screws on the main PCB.
4. Lift the main PCB out of the front panel.

Installation

1. Position the main PCB onto the standoffs in the front panel.
2. Tighten (7) Phillips pan-head screws on the main PCB.

3. Connect the following to the main PCB:

J801	20-pin	from J801 on the flow sensor PCB (in harness)
J1210	5-pin (gray top, green)	from the flow sensor PCB (in P/N 15961 harness)
J3	10-pin	from the flow sensor PCB (in P/N 15961 harness)
J1211	5-pin (blue wire-top)	from the SVGA PCB
J1	5-pin (orange wire)	from SVGA PCB (position wire on 2nd pin from right)
J1	5-pin (gray-left)	from SVGA PCB
J601	5-pin	from SVGA PCB

Note

The J1 position on the main PCB is located above the J601 connector and accepts two 5-pin connectors; the connector with one wire above the connector with three wires.

4. Install the front panel, left panel, right panel, battery tray, top cover, and power cable.

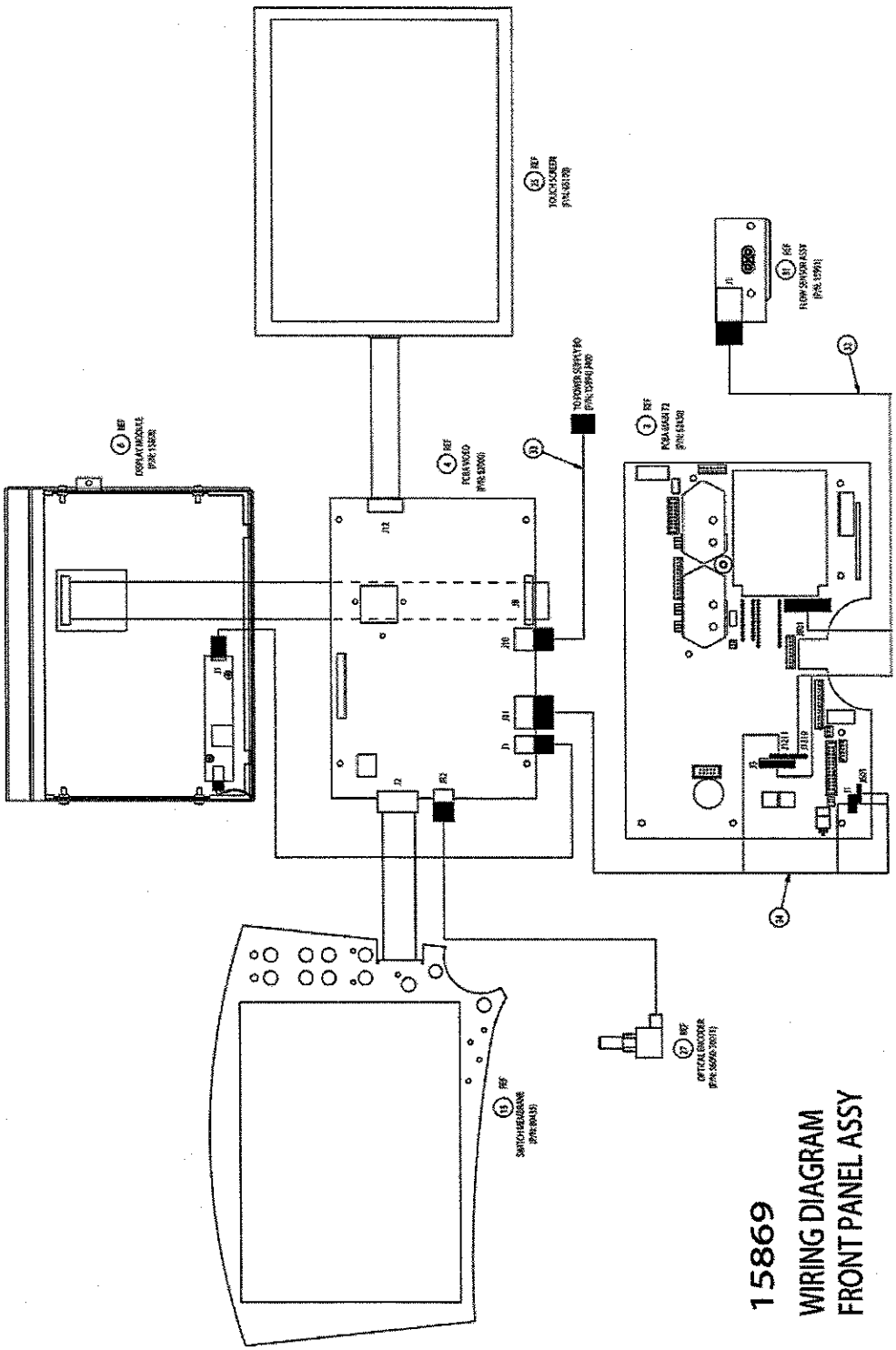


Figure 3.9 Front Panel wiring diagram

Flow Sensor PCB assembly P/N 15991

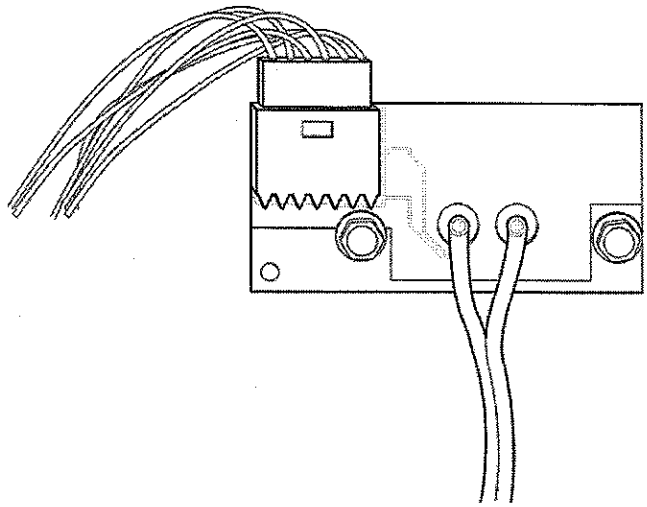


Figure 3.10 Flow Sensor PCB assembly

Removal

1. Remove the power cable, top cover, battery tray, right panel, left panel, front panel, and main PCB.
2. Disconnect the (2) 1/16" ID tubes to the main tubing harness.
3. Disconnect the following from the flow sensor PCB:
   J1 6-pin (grey) to main PCB P/N 15961
4. Remove the (2) 1/4" nuts on the flow sensor PCB.
5. Lift off the flow sensor PCB.

Installation

1. Position the flow sensor PCB onto the two standoffs.
2. Install the (2) 1/4" nuts on the flow sensor PCB.
3. Connect the following to the flow sensor PCB:
   J1 6-pin (grey) from the main PCB P/N 15961
4. Connect the (2) 1/16" ID tubes from the main tubing harness, #2 and #3 (with a black line on it).
5. Install the main PCB, front panel, left panel, right panel, battery tray, top cover, and power cable.

Exhalation Valve Assembly P/N 15871

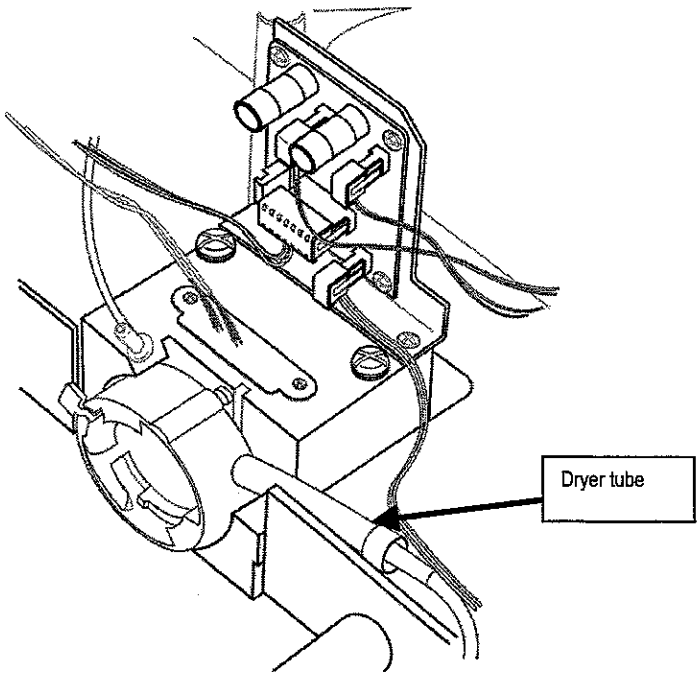


Figure 3.11 Exhalation Valve Assembly

Removal

1. Remove the power cable, top cover, battery tray, right panel, left panel, and front panel.
2. Disconnect the following from the FIO2 monitoring PCB:

J2	2-pin (clear conn.)	to oxygen sensor
J3	2-pin (blue conn.)	to oxygen inlet solenoid on blender assembly
J4	2-pin (red conn.)	to nebulizer solenoid assembly on upper rear of blender

3. Remove (2 Phillips pan-head screws on the valve cover.
4. Lift out the exhalation valve assembly.

Installation

1. Ensure the dryer tube is securely attached to the nipple on the exhalation valve assembly.
2. Seat the valve onto the standoffs, with the PCB towards the inside of the unit.
3. Install the valve cover using (2) Phillips panhead screws.
4. Connect the following to the FIO2 monitoring PCB:

J2	2-pin (clear conn.)	from oxygen sensor
J3	2-pin (blue conn.)	from oxygen inlet solenoid on blender assembly
J4	2-pin (red conn.)	from nebulizer solenoid assembly on upper rear of blender

5. Install the front panel, left panel, right panel, battery tray, top cover, and power cable.

Inspiratory Hold Solenoid and Check Valve Assembly P/N 10346

Removal

1. Remove the power cable, top cover, battery tray, and left panel.
2. If the front panel is installed, disconnect the cable from J302 on the main PCB.
3. Remove (2) Phillips pan-head screws and lift out the solenoid.
4. Lift out the spring and check valve assembly.

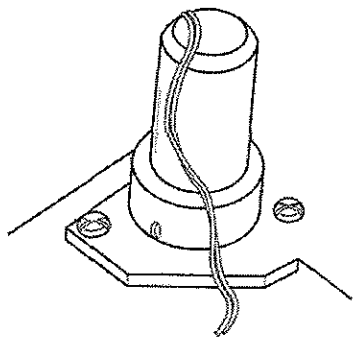


Figure 3.12 Inspiratory Hold Solenoid

Installation

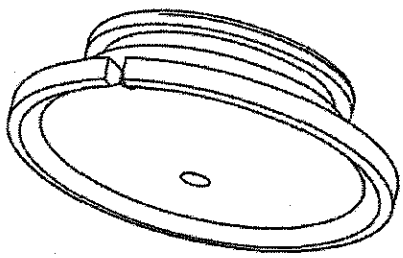


Figure 3.13 Umbrella check valve (P/N 21950)

1. Place the spring (P/N 21971) into the center of the check valve (P/N 21950).
2. Slip the solenoid over the spring using the guide and seat into place.
3. Install (2) Phillips pan-head screws.
4. If the front panel is installed, connect the cable from J302 on the main PCB.
5. Install the left panel, battery tray, top cover, and power cable.

Manifold Base assembly

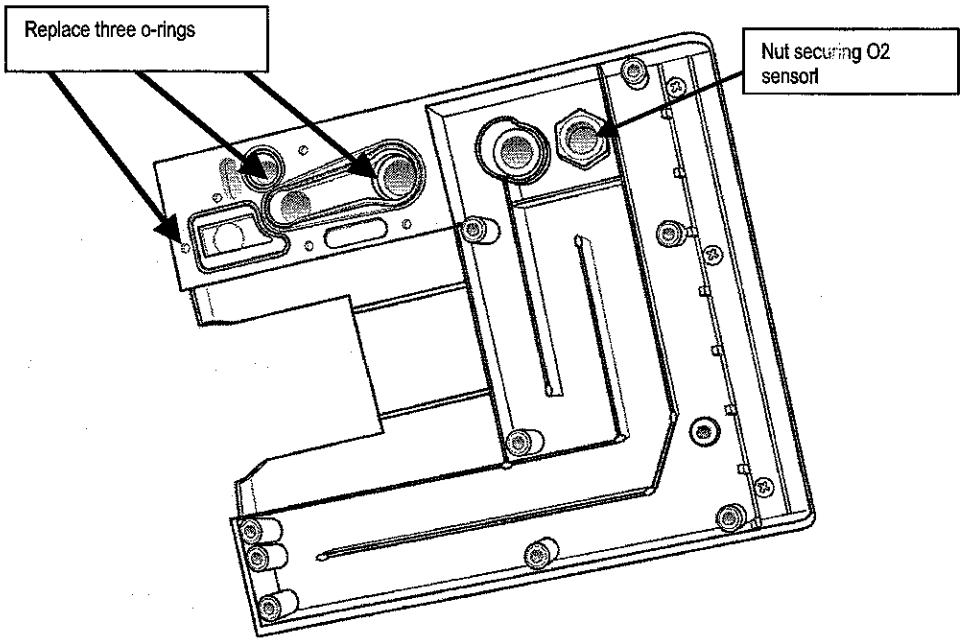


Figure 3.14 Manifold base assembly (early model Vela units only), bottom panel & O2 hose removed

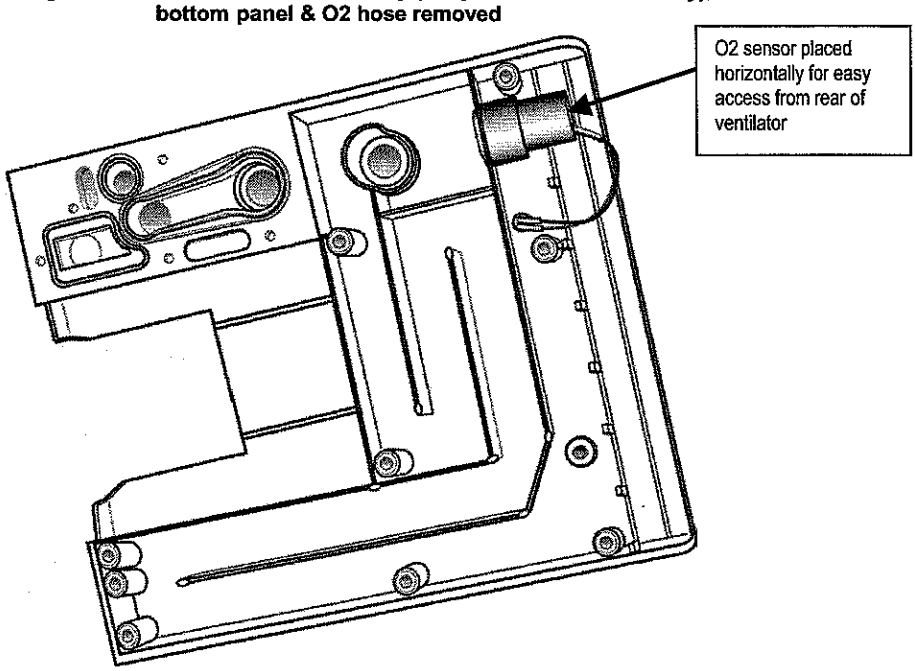


Figure 3.15 Manifold Base assembly showing horizontal O2 cell for easy removal.

Removal

1. Remove the power cable, top cover, and battery tray.
2. Carefully turn the unit onto its side.
3. Remove (2) Phillips countersink screws that hold the safety check valve guard, and remove the guard.
4. Remove (4) rubber feet.
5. If the left panel is installed, remove (3) Phillips pan-head screws on the left side of the bottom panel, and if the front panel is installed, remove (2) Phillips pan-head screws at the front of the bottom panel.

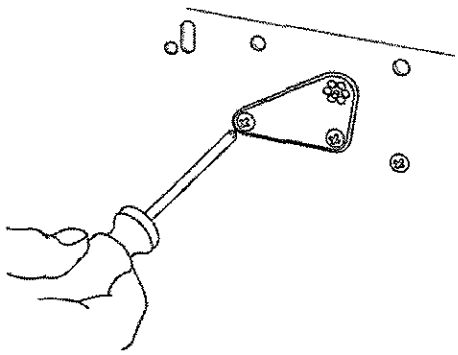


Figure 3.15 Removal of safety check valve guard

6. Remove (7) Phillips pan-head screws on the outside of the bottom panel.
7. Gently remove the bottom panel.
8. Remove the three visible o-rings from the underside of the unit, part number 30018, 30023 and 04358see figure 3.X.
9. Pull off the oxygen diffuser tube from the nipple and remove it from the channel base, see figure 3.15

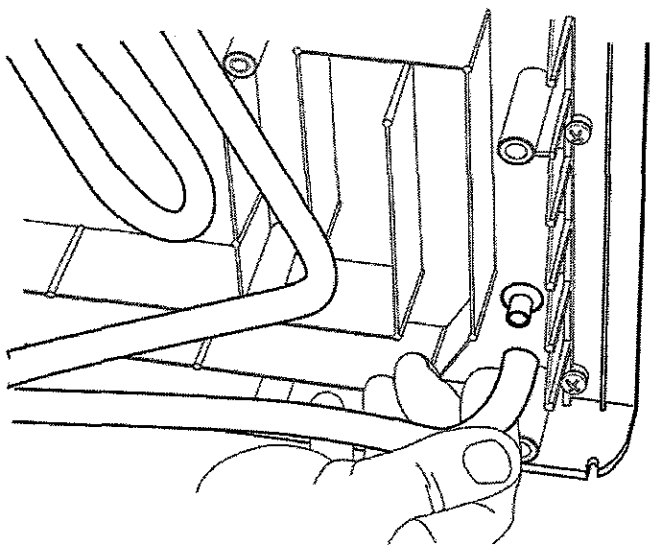


Figure 3.16 Removing the O2 diffuser tube

Installation

1. Carefully turn the unit upside down.
2. Attach the curved portion of the oxygen diffuser tube to the nipple and push into place. Place the remaining portion of the tube inside the channel base in the underside of the unit.
3. Insert the three o-rings- into the underside of the unit, noting that each o-ring has a different shape.
4. Ensure that all three o-rings are in place and position the bottom panel over the three screw holes at the front.

5. Install (7) Phillips panhead screws on the bottom panel.
6. If the left panel is installed, install (3) Phillips pan-head screws on the left side of the bottom panel, and if the front panel is installed, install (2) Phillips pan-head screws at the front of the bottom panel.
7. Install (4) rubber feet.
8. Install the safety check valve guard with (2) Phillips countersink screws.
9. With the unit upright, install the battery tray, top cover, and power cable.

Oxygen Sensor part number 15972

For early model Vela units do the following:

Removal

1. Remove the power cable, top cover, battery tray, left panel, and bottom panel.
2. Turn the unit on its side.
3. Remove the 1" mounting nut from the manifold base (see figure 3.14) and pull the sensor from the manifold.

Note

To remove the O2 sensor only when complete disassembly is not required, simply grasp the sensor in place and unscrew from the retaining nut leaving the nut in place in the base.

Installation

1. Ensure the o-ring is installed into the oxygen senor.
2. With the unit on its side, place the sensor into the manifold and install the 1" mounting nut.
3. Install the bottom panel, left panel, battery tray, top cover, and power cable.

For later model Vela units (usually 1400 series or later) do the following:

Removal

On the bottom rear of the Vela, unscrew the EMI shield containing the foam ambient air filter and lift out the shield and filter together.

The O2 sensor is visible on the left . Using needle nose pliers, disconnect the O2 filter connector. Pull firmly straight back on the O2 sensor to remove.

Installation

Seat the new O2 filter and re-connect.

Replace the EMI shield containing the foam ambient air filter and re-attach the screws securing it in place.

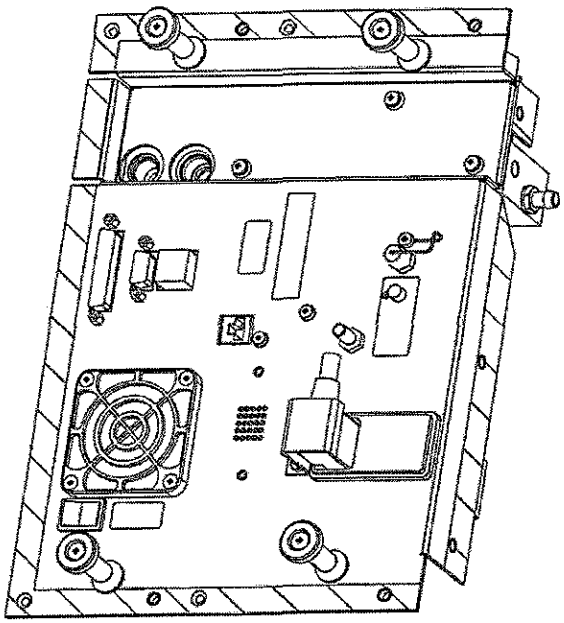
Rear Panel part number 15892

Removal

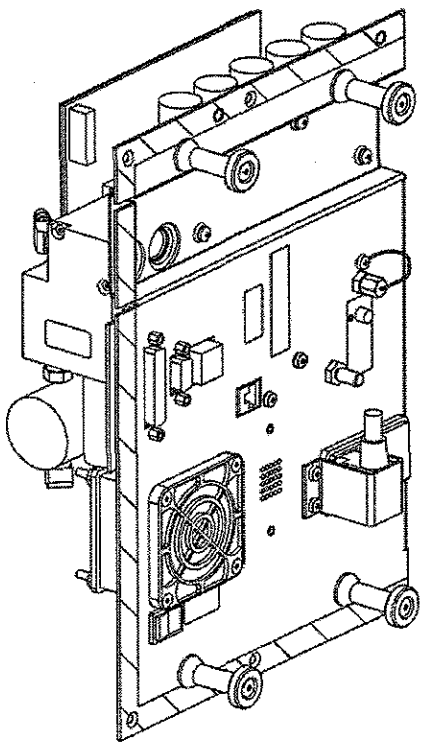
1. Remove the power cable, top cover, battery tray, right panel, and left panel.
2. With the unit upright, disconnect the following from the turbine motor driver PCB:
   P2 10-pin to main PCB and power PCB via main harness
3. Cut the two tie wraps that hold the main harness and the tie wrap that holds the blender cable to the turbine.
4. Turn the unit on its side.
5. Remove (3) Phillips pan-head screws on the rear panel.
6. Slide the fiber optic cable from under the turbine muffler assembly.
7. Remove the rear panel from the manifold base.

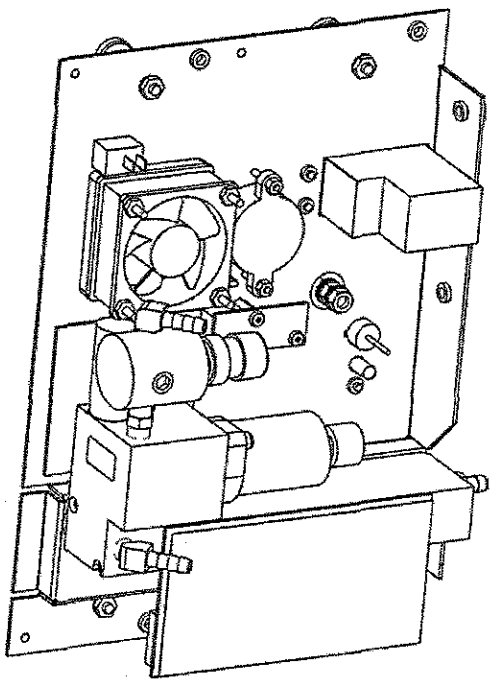
Installation

1. Carefully place the unit on its side and run the fiber optic cable under the muffler tubes.
2. Direct the blender nipple on the rear panel through the hole in the manifold base.
3. Install (3) Phillips pan-head screws on the rear panel, ensuring that the blender nipple is centered.
4. With the unit upright, install the blender cable tie wrap to the turbine, and install the two tie wraps that hold the main harness onto the tie mounts, noting that the tie wraps are positioned where the wires all run parallel.
5. Connect the following to the turbine motor driver PCB:
   P2 10-pin from main PCB and power PCB via main harness
6. Install the left panel, right panel, battery tray, top cover, and power cable.



REAR PANEL ASSY
15892 Rev X4





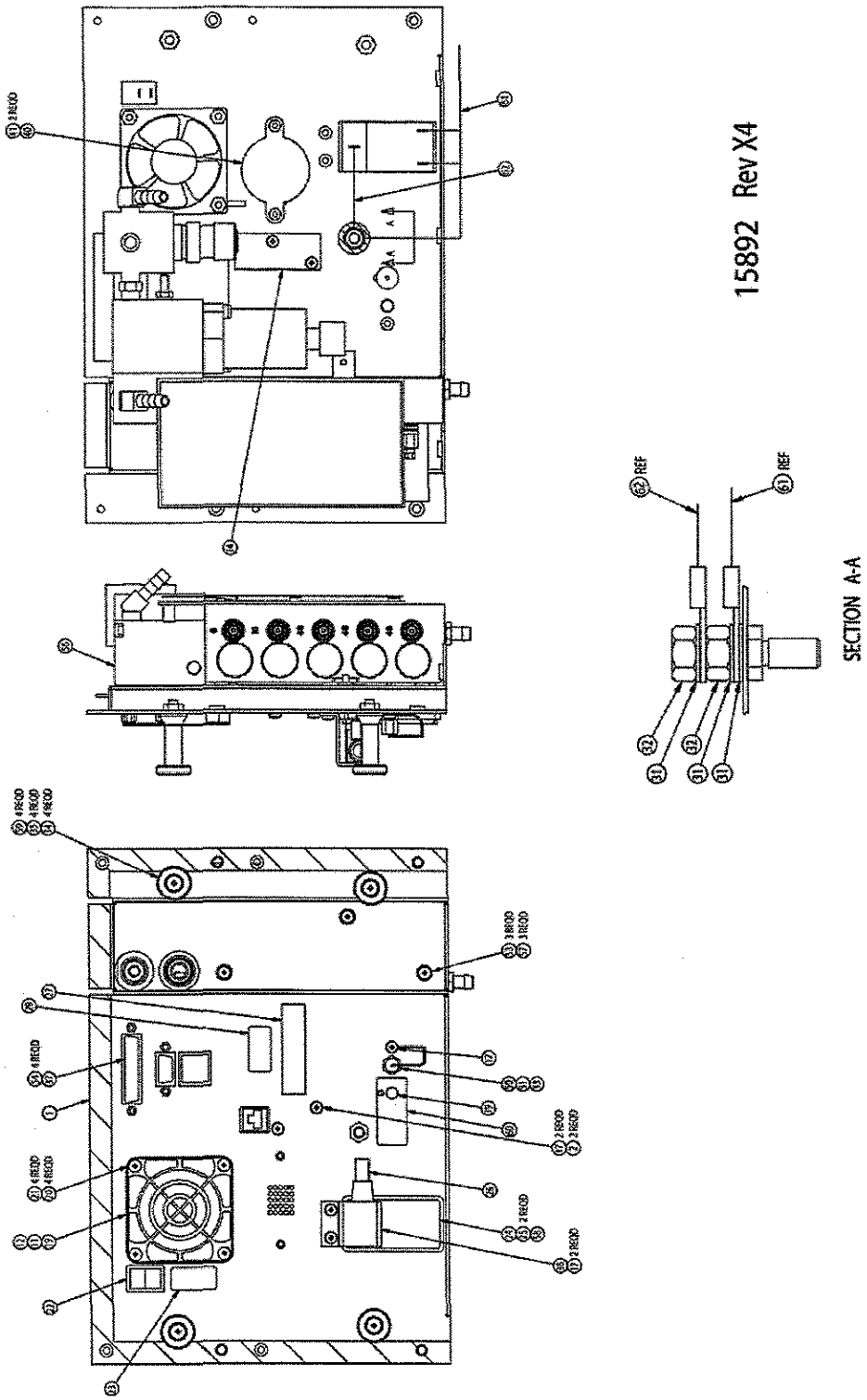


Figure 3.17 Rear Panel views

Turbine and Muffler Assembly

Removal

1. Remove the power cable, top cover, battery tray, right panel, left panel, and blender.
2. If the front panel is installed, disconnect the cable from J701 on the main PCB, disconnect the green oxygen nebulizer tube, and disconnect the blender cable.
3. If installed, use a 3/4" wrench to remove the high and low pressure oxygen fittings from the rear of the unit, noting that the high pressure fitting is located above the low pressure fitting (see figure 3.18).

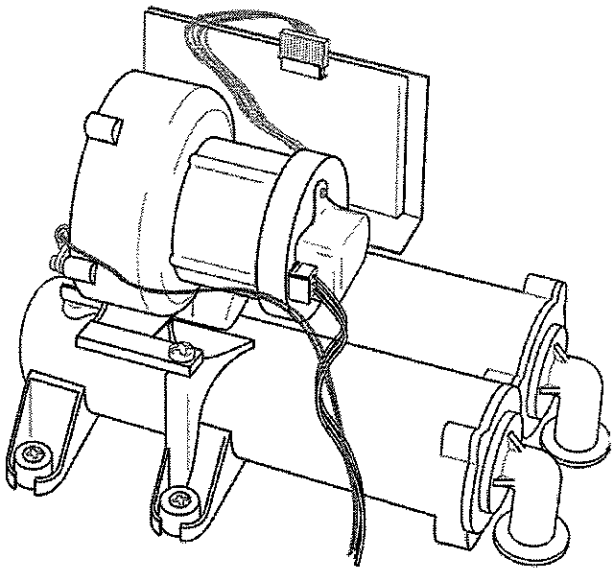


Figure 3.18 Turbine & Muffler assembly

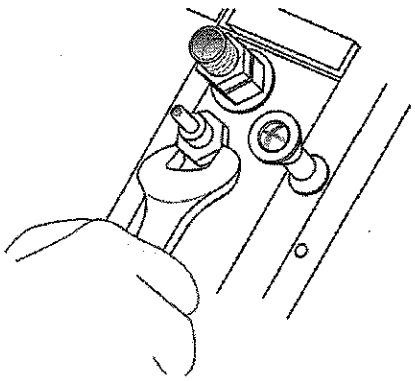


Figure 3.19 High & low pressure O2 fittings on back panel

4. Remove (5) Phillips pan-head screws.
5. Disconnect the gray silicone intake and output elbows by gently pulling them out from the muffler tubes.
6. Lift the assembly off the manifold base.
7. Gently pull up the elbows to remove.

Installation

1. Insert the elbows into the manifold base.
2. Set the turbine and muffler assembly onto the manifold.
3. Install (5) Phillips pan-head screws.
4. If removed during this procedure, use a 3/4" wrench to install the high and low pressure oxygen fittings to the rear of the unit, noting that the high pressure fitting is located above the low pressure fitting.
5. Connect the gray silicone intake and output elbows by inserting them into the muffler tubes. Push once in the center of each elbow to properly seat.
6. If the front panel is installed, connect the cable to J701 on the main PCB, connect the green oxygen nebulizer tube, and connect the blender cable.
7. Install the blender, left panel, right panel, battery tray, top cover, and power cable.

Over Pressure Relief Valve assembly

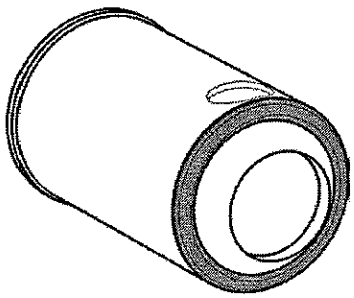


Figure 3.20 Over Pressure Relief Valve assembly with o-ring

Removal

1. Remove the power cable, top cover, battery tray, right panel, left panel, and front panel.
2. Use a flat screwdriver to pry the valve from its location at the front left side of the manifold base.
3. Remove the o-ring (P/N 08963).
4. Using a flat screwdriver in the middle slot, unscrew the adjuster in the middle of the valve and remove the two o-rings (P/N 30005 in the relief valve poppet and P/N 30017 on the brass adjuster).

Installation

1. Install the two o-rings (P/N 30005 in the relief valve poppet and P/N 30017 on the brass adjuster).
2. Slide the housing over the poppet and screw clockwise into the housing, tightening with a flat screwdriver.
3. Slide the valve into place in the manifold base, ensuring that the adjustment screw is in the notch.

CAUTION

Do not adjust the screw in the relief valve, since it must be factory calibrated.

4. Push until the valve is seated into place.
5. Install the front panel, left panel, right panel, battery tray, top cover, and power cable.

Turbine Motor Driver PCB part number 71597

Removal

1. Remove the power cable, top cover, battery tray, right panel.
2. Disconnect the following from the turbine motor driver PCB:

P1	8-pin	to the turbine
P2	10-pin	to J6 on the power PCB

3. Remove the (2) keps screws.
4. Lift off the PCB.

Note

Do not remove the turbine from the turbine muffler assembly. They are supplied complete.

Installation

1. Position the turbine motor driver PCB on the right side of the turbine assembly, on top of the filter holder, with the board toward the turbine.
2. Install (2) keps screws.
3. Connect the following to the turbine motor driver PCB:

P1	8-pin	from the turbine
P2	10-pin	from J6 on the power PCB

4. Install the right panel, battery tray, top cover, and power cable.

Muffler/Filter Assemblies part number 10364

Removal

1. Remove the power cable, top cover, battery tray, and left panel.

2. Remove (6) Phillips pan-head screws on the filter cover.

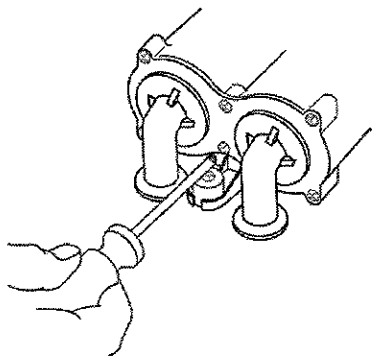


Figure 3.21

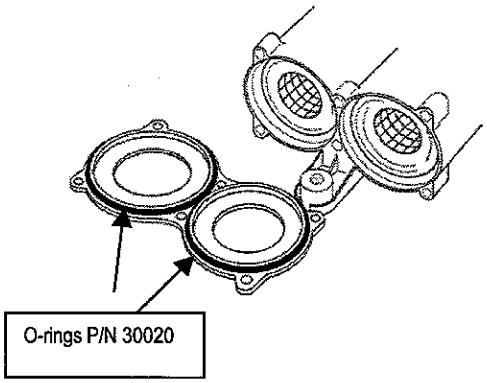


Figure 3.22

3. Remove the cover and the two o-rings (P/N 30020).

4. Use needle-nosed pliers to pull out both the left and right filter assemblies. The right assembly has the filter sock

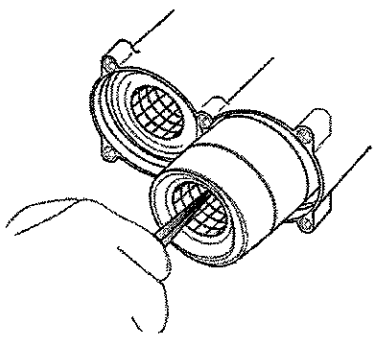


Figure 3.23

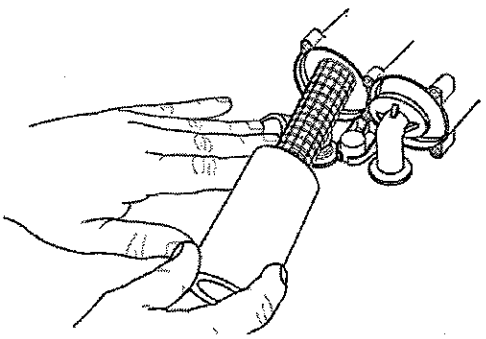


Figure 3.24

Installation

1. Insert the muffler (output) into the left tube (see picture) and the sock filter (input) into the right tube. The right and left muffler/filter assemblies are sold together as part number 10365.
2. Install two o-rings (P/N 30020).
3. Install the cover using (6) Phillips pan-head screws.
4. Install the left panel, battery tray, top cover, and power cable.

Blender Assembly Part Number 15895

Removal

1. Remove the power cable, top cover, battery tray, and right panel.
2. If the rear panel is installed, remove the high and low pressure oxygen fittings from the rear panel using a 3/4" wrench, noting that the high pressure fitting is located above the low pressure fitting.
3. If the rear panel is installed, disconnect the 40-pin ribbon cable from the SVGA out PCB.
4. If the front panel is installed, disconnect the green oxygen nebulizer tube.
5. Disconnect the following from the blender PCB:

   J301, 12-pin connector to J301 on the main PCB

6. Remove the bottom strip ambient air inlet filter by pinching and pulling it out.

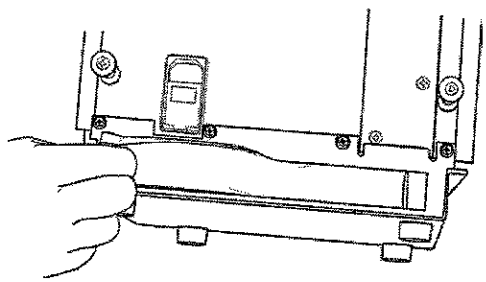


Figure 3.25 Ambient air filter

7. Remove (3) Phillips pan-head screws on the right side of the rear panel.
8. Use needle-nosed pliers to disconnect the oxygen diffuser tube as you remove the blender assembly.
9. If the exhalation valve assembly is installed, disconnect the following from the FIO2 PCB:

J3	2-pin (blue conn.)	to oxygen inlet solenoid on blender assembly
J4	2-pin (red conn.)	to nebulizer solenoid assembly on upper rear of blender

Installation

1. If the exhalation valve assembly is installed, connect the following to the FIO2 PCB:

J3	2-pin (blue conn.)	from oxygen inlet solenoid on blender assembly
J4	2-pin (red conn.)	from nebulizer solenoid assembly on upper rear of blender

2. Position the blender assembly inside the unit.
3. Use needle-nosed pliers to feed the oxygen diffuser tube through the hole in the rear panel and connect it to the blender nipple.
4. Install (3) Phillips pan-head screws on the right side of the rear panel.
5. Install the bottom strip ambient air inlet filter.
6. Connect the following to the blender PCB:

301	12-pin	from J301 on the main PCB

7. If the front panel is installed, connect the green oxygen nebulizer tube.
8. If the rear panel is installed, connect the 40-pin ribbon cable to the SVGA out PCB.
9. If the rear panel is installed, install the high and low pressure oxygen fittings to the rear panel using a 3/4" wrench, noting that the high pressure fitting is located above the low pressure fitting.
10. Install the right panel, battery tray, top cover, and power cable.

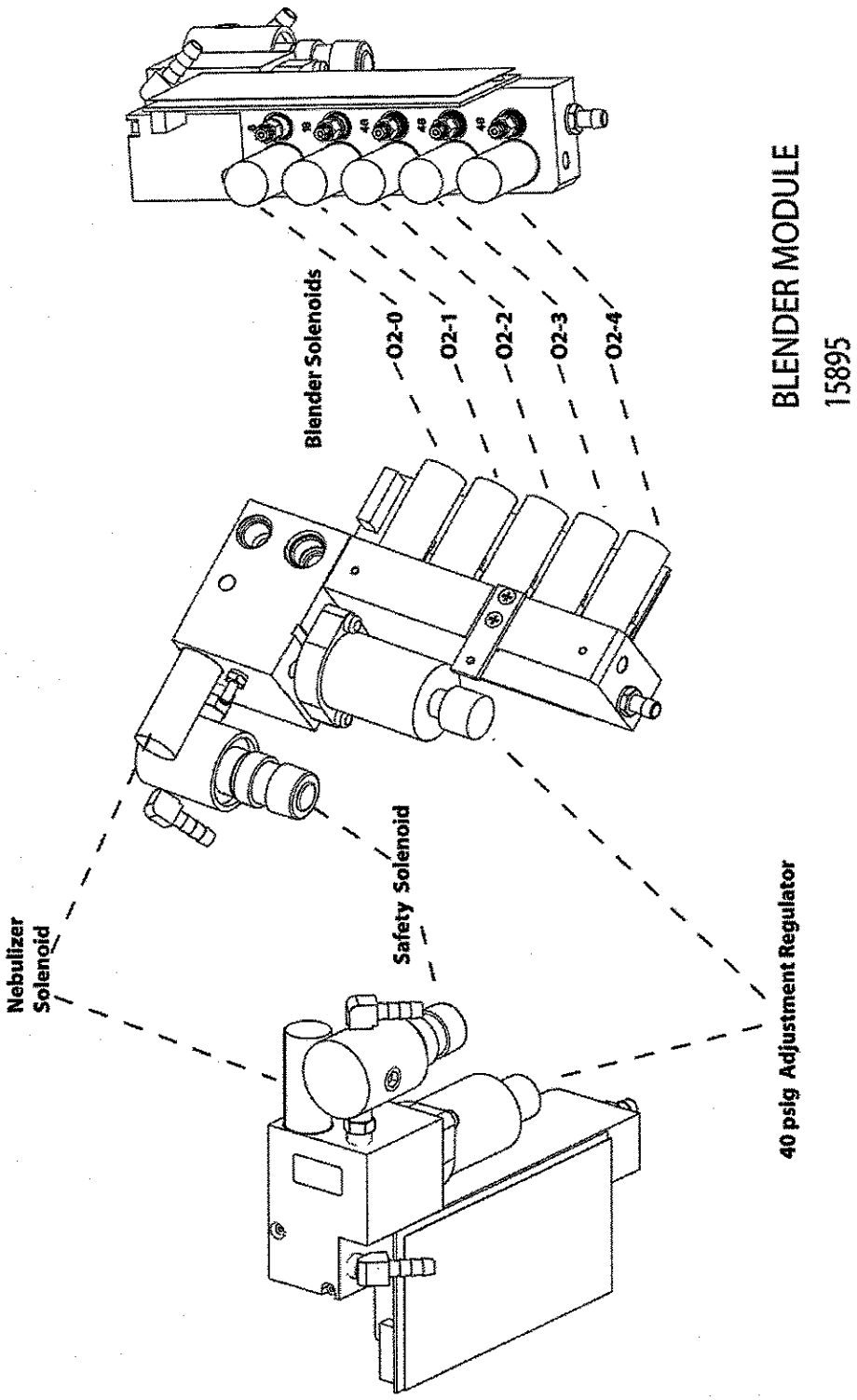


Figure 3.26 Blender Assembly

Fan Assembly part number 15500

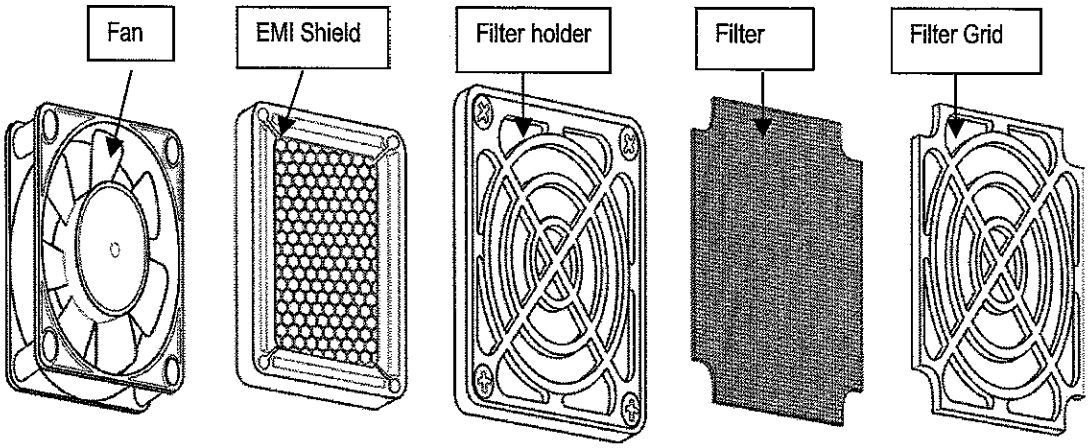


Figure 3.27 Fan Assembly blow out

Removal

1. Remove the power cable, top cover, and battery tray.
2. Use a 5/16" nut driver to remove the inside nuts and a short (#2) Phillips screwdriver to remove the (4) Phillips pan-head outside screws on the fan assembly.
3. Remove the fan and ESD shield from the inside of the unit, and the filter grid from the rear of the unit.
4. Disconnect the fan cable from J2 on the power PCB.

Installation

1. Place the fan filter inside the external fan cover. Align with 4 attachment holes, and hold it against the rear panel.
2. Hold the ESD shield to the inside of the rear panel with the copper contact strips touching the rear panel.
3. Place the fan onto the ESD shield with the label to the inside of the unit and the wire at the bottom.
4. Use a 5/16" nut driver to install the nuts from the inside and a short (#2) Phillips screwdriver to install the (4) Phillips pan-head machine screws onto the fan assembly from the outside.
5. Connect the fan cable to J2 on the power PCB.
6. Install the battery tray, top cover, and power cable.

Chapter 4 Operational Verification and Calibration

Operational Verification Testing

Prior to using the Vela ventilator on a new patient the following checks should be carried out to ensure optimum performance. **Verification testing should always be performed "off patient".**

WARNING

Disconnect patient from the ventilator before performing verification testing.

Note

All personnel performing preventive maintenance and product repair must be trained and certified by VIASYS Healthcare to service the product

Note

If any portion of the following performance check fails, and you are unable to correct the problem, contact your VIASYS Healthcare Certified Service Technician.

First perform the User Verification Tests (UVTs). To access the UVTs, do the following'

1. After disconnecting the patient, turn the ventilator OFF (i.e., STANDBY).
2. Press and hold the **Accept** button.
3. While holding the **Accept** button, turn the ventilator ON. Continue to hold the button until the ventilator completes the Power On Self Tests (POST).
4. Release the **Accept** button when the UVT menu appears in the screen. The Audible Alarm sounds. Press Alarm Reset button to clear.

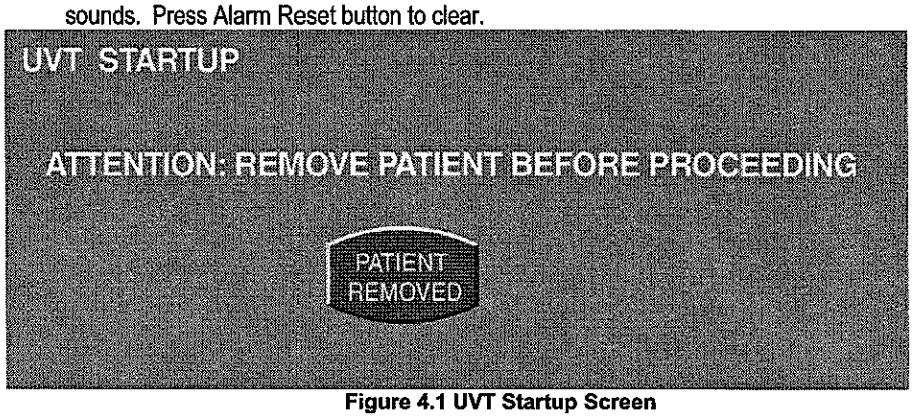


Figure 4.1 UVT Startup Screen

5. Press the **Patient Removed** touch screen icon, the UVT test selection screen displays (see figure 4.2).

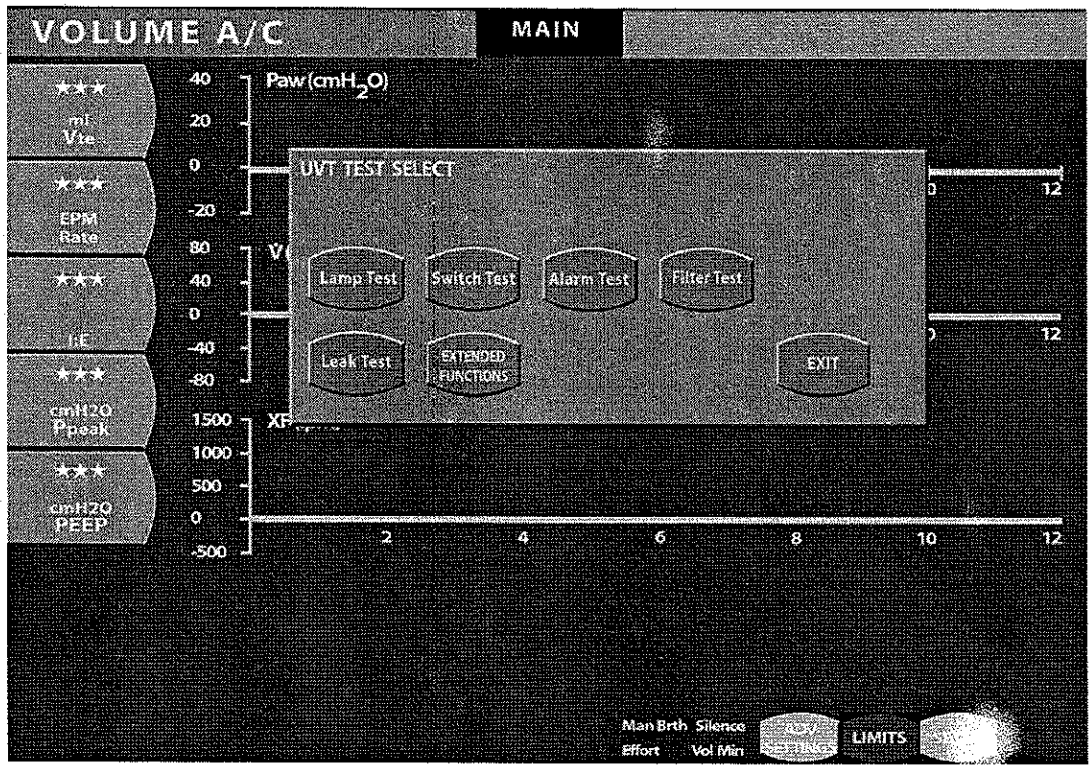


Figure 4 2 The UVT Screen with the Main screen in Service mode

6. Press the appropriate touch screen icon to begin a test.

Lamp Test

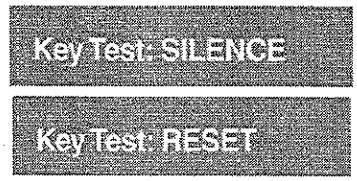
Run this test to check the front lamps to make sure they are functioning properly.

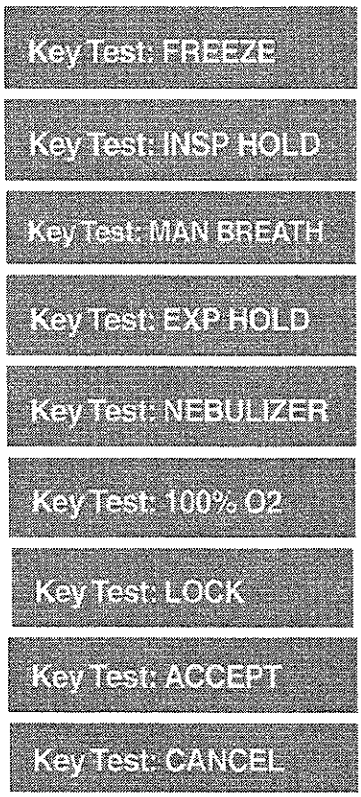
1. Press the **LampTest** touch screen icon to start the test. The ventilator illuminates all front panel LEDs.
2. Press the **LampTest** touch screen icon again to turn the LEDs off and exit the test.

Switch Test

Run this test to check the front panel membrane switches to make sure they are working properly.

1. Press the **SWITCH TEST** icon.
2. Press each membrane switch control in turn. Watch for the name of the control to appear in the message bar at the bottom left of the touch screen as follows:





3. Press the **SWITCH TEST** icon again to exit the test.

Alarm Test

Run this test to check the audible alarm.

1. Press the **Alarm Test** touch screen icon to start the test. The audible alarm sounds.
2. Press the **Alarm Test** touch screen icon again to silence the audible alarm and exit the test.

Filter Test

Run this test to check the differential pressure across the turbine inlet filter. A high differential pressure may indicate a dirty or occluded filter.

1. Press the **Filter Test** touch screen icon. The turbine accelerates flow to 140 lpm and checks the differential pressure to make sure it is within range. At the end of the test, the ventilator displays a pass or fail message. If the test passes, the following message appears:

   x.x Passed

   where x.x is the average turbine differential pressure and P indicates the test passed.

   If the test fails, the following message appears:

   x.x Failed

   where x.x is the average turbine differential pressure and F indicates the test failed:

2. If the test fails, check the rotation of the turbine inlet filter to make sure that the seam is horizontally oriented and run the test again. If the test fails again, contact a Bird Certified Service Technician.

Leak Test

Note

*This test should be performed with **all circuit accessories installed** (e.g., humidifier, water traps, and so on.) Make sure al connections are secure and all openings occluded before beginning the test.*

Run this test to make sure the patient breathing circuit is not leaking.

1. Attach a one-liter test lung (P/N 33754) at the patient breathing circuit wye.
2. Press the **Leak Test** touch screen icon to run the test. The test begins by increasing the pressure in the patient breathing circuit to 60 cmH2O. The ventilator then displays the following messages in sequence:

   Leak test requested
   Leak test in progress
3. The ventilator then waits 10 seconds and measures the circuit pressure again. If the difference between the starting and ending measurements is less than or equal to 6 cmH2O, the test passes and the ventilator displays the following message:

   xx.x Passed

   where xx.x is the ending measurement.
4. Otherwise, if the difference is more than 6 cmH2O, the test fails and the ventilator displays the following message:

   xx.x Failed
5. If the test fails, check all connections to make sure there are no leaks and repeat the test.
6. It the test fails again, refer to Chapter 5, for troubleshooting procedures

Exit

To exit the UVTs press the **EXIT** touch screen icon.

Extended Functions

The Extended Functions menu may be accessed via the UVT Test Select screen as described in the previous section. Press the EXTENDED FUNCTIONS icon from the UVT screen.

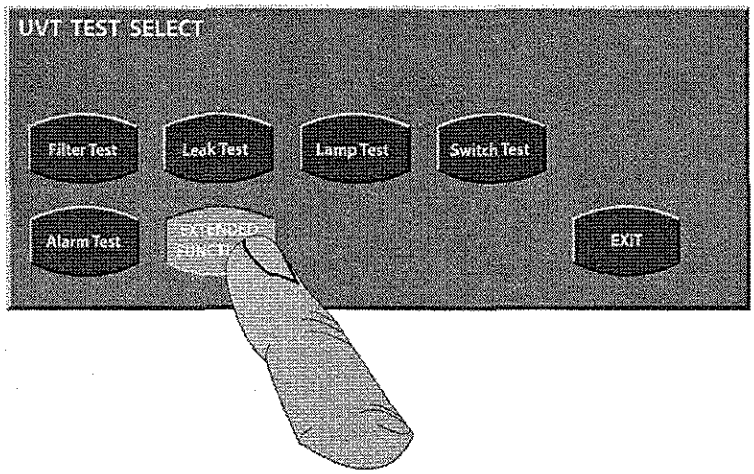


Figure 4.3 Accessing the Extended Functions Screen from the UVT menu

You can also access the extended functions screen via the Screens menu during normal operation.

Press the screen display area on the top center of the touch screen to activate Screen Select menu.

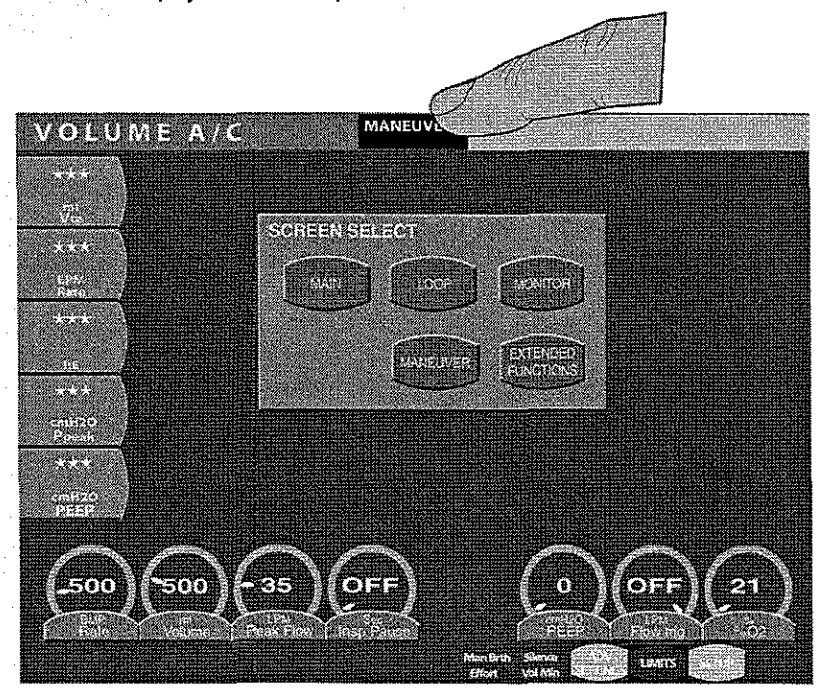


Figure 4.4 Accessing the Extended Functions screen from the Screen Select menu

Press the EXTENDED FUNCTIONS touch screen icon to display the Extended Functions screen.

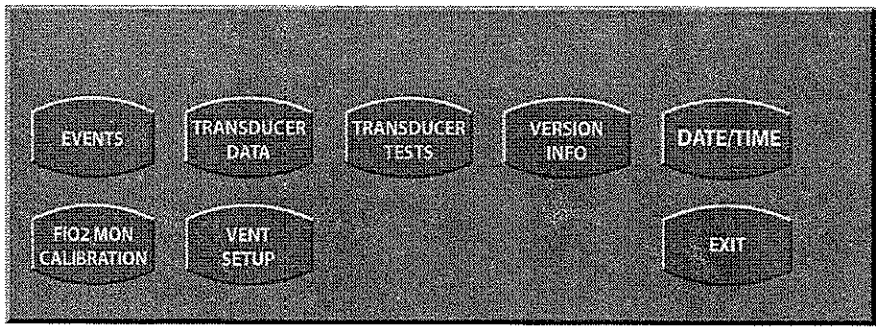


Figure 4.1 Extended Functions screen menu

Events

To access the Events list, press the Events screen icon

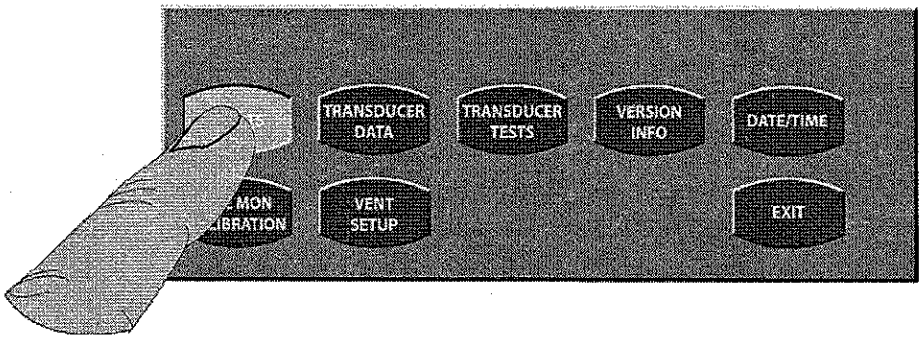


Figure 4.2 Press the Events touch screen icon

A list of chronological events displays with the latest event at the top as shown in figure 4.11

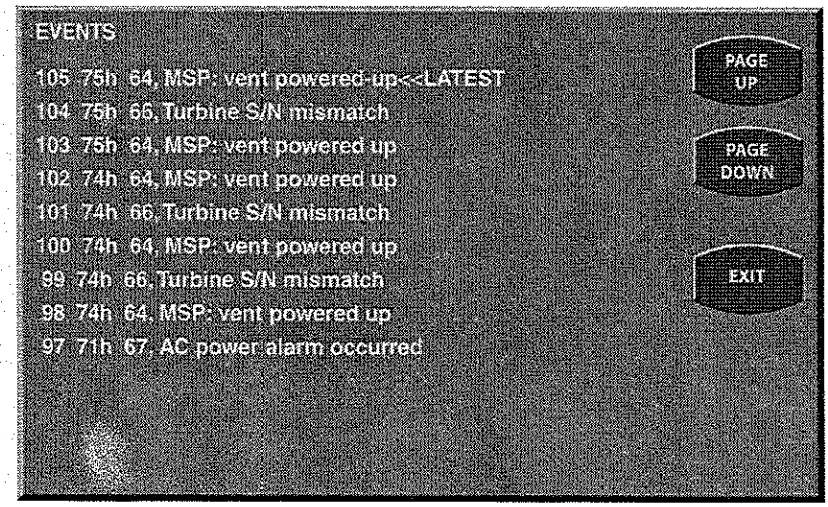

EVENTS
105 75h 64, MSP: vent powered-up<<LATEST
104 75h 66, Turbine S/N mismatch
103 75h 64, MSP: vent powered up
102 74h 64, MSP: vent powered up
101 74h 66, Turbine S/N mismatch
100 74h 64, MSP: vent powered up
99 74h 66, Turbine S/N mismatch
98 74h 64, MSP: vent powered up
97 71h 67, AC power alarm occurred
PAGE UP
PAGE DOWN
EXIT

Figure 4.3 The Events screen

Transducer Data

Press the Transducer Data screen icon.

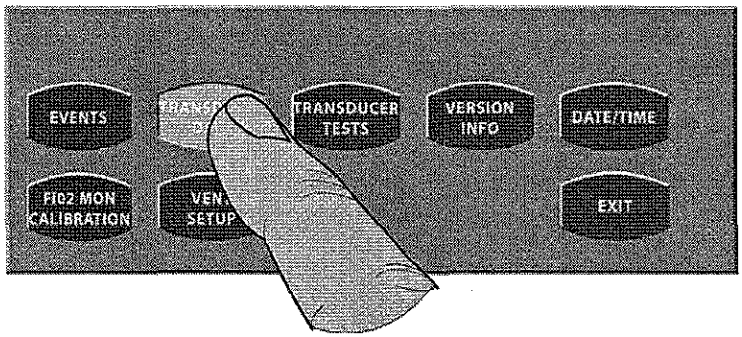


Figure 4.4 Press the Transducer Data screen icon

The Transducer Selection screen displays.

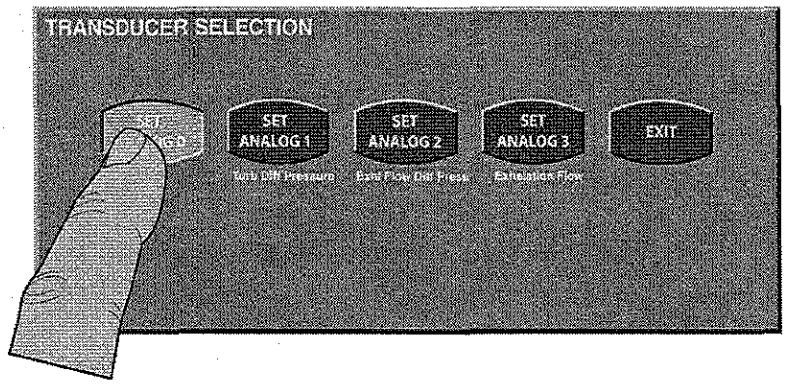


Figure 4.5 Transducer data selection screen

From here you can set the analog data display associated with each transducer. For example, if you press the SET ANALOG 0 screen icon as shown in figure 4.X, the following options display in a drop down menu.

Exhl Flow Diff Press
Exhalation Flow
Turbine Flow
Turbine Speed

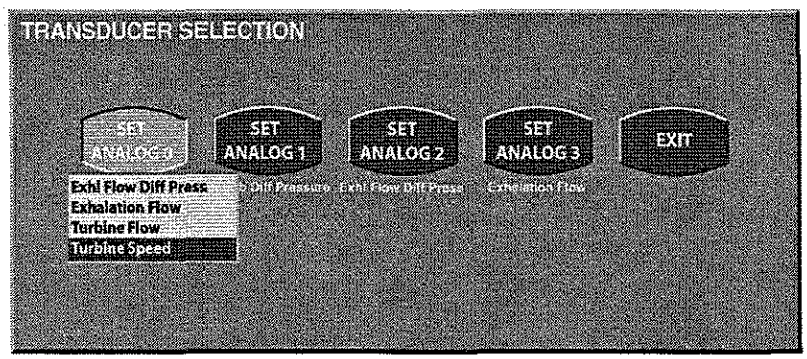


Figure 4.6 Transducer data selection options

In this example, the transducer associated with Analog 0 is set to display Turbine Speed.

Set each analog value to one of the transducers in the drop down menu. Press EXIT to return to the Extended Functions screen.

For instructions on how to view this data as a displayed waveform, see Chapter 5, Maintenance & Troubleshooting.

Transducer Tests

To access the transducer test screen press the Transducer Tests screen icon.

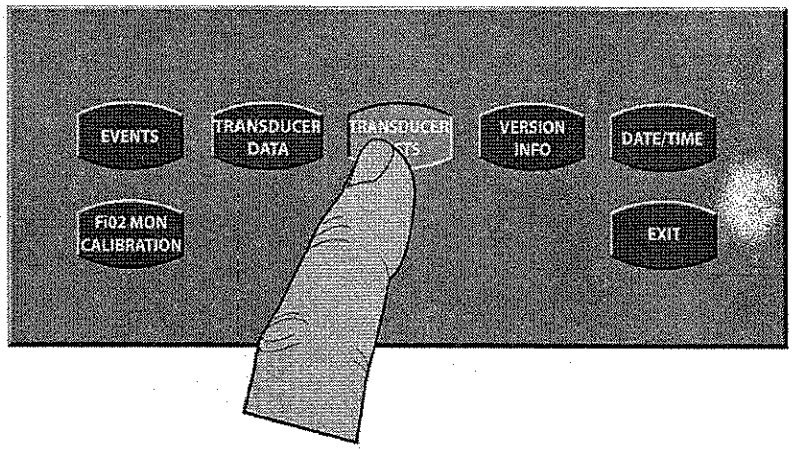


Figure 4.7 Press transducer tests icon

The transducer tests screen appears with icons for the Turbine Differential, Exhalation Differential and Circuit Pressure transducers.

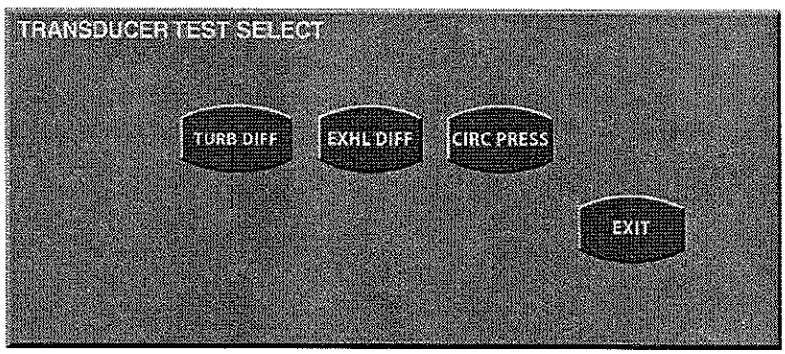


Figure 4.8 Transducer test screen

Press the Turbine Differential (TURB DIFF) screen icon.

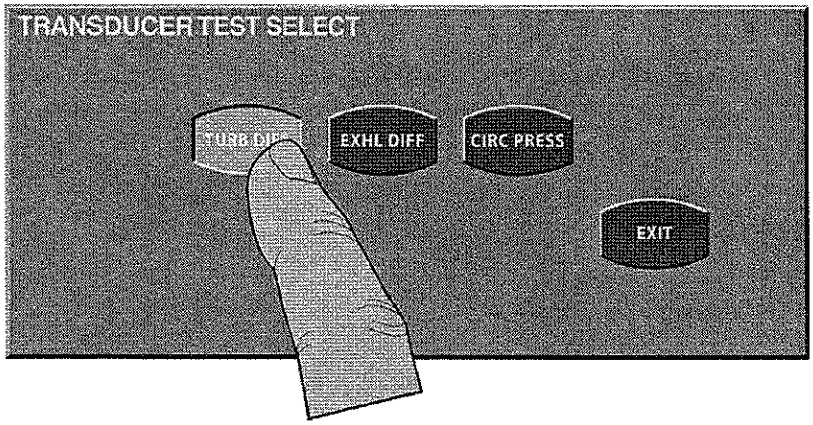


Figure 4 9 Press TURB DIFF icon

The following messages appear in sequence in the message area at the bottom left of the touch screen.

Turb Diff Pressure Xdcr Test – Requested

Turb Diff Pressure Xdcr Test – In Progess

Turb Diff: XXX Passed (where XXX is the transducer reading within range)

Or

Turb Diff: XXX Failed (where XXX is the transducer reading OUT of range)

Press the Exhalation Differential Pressure (EXHL DIFF) screen icon.

The following messages appear in sequence in the message area at the bottom left of the touch screen.

Exhl Diff Pressure Xdcr Test – Requested

Exhl Diff Pressure Xdcr Test – In Progess

Exhl Diff: XXX Passed (where XXX is the transducer reading within range)

Or

Exhl Diff: XXX Failed (where XXX is the transducer reading OUT of range)

Press the Circuit Pressure (CIRC PRESS) screen icon.

The following messages appear in sequence in the message area at the bottom left of the touch screen.

Circ Pressure Xdcr Test – Requested

Circ Pressure Xdcr Test – In Progess

Circ Press: XXX Passed (where XXX is the transducer reading within range)

Or

Circ Press: XXX Failed (where XXX is the transducer reading OUT of range)

Version Information

To access the software version information screen, press the VERSION INFO screen icon.

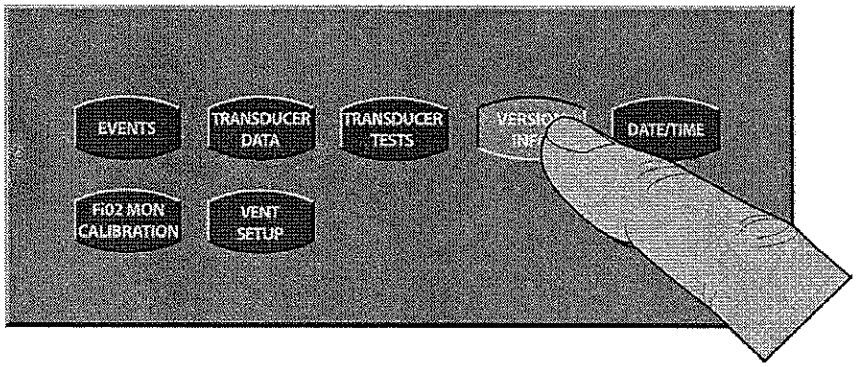


Figure 4.10 Press the Version Info icon

The Versions screen, showing the versions of all software installed on the machine, displays.

Note

The version information shown in figure 4.X is an example only. Your machine will have different versions of software depending on the date of sale and the updates loaded.

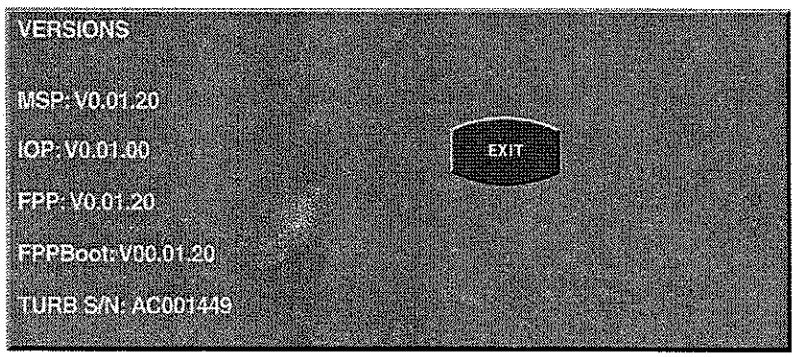


Figure 4 11 Sample Version information screen